ANIMAL HUSBANDRY AND FISHERIES
RESOURCES DEPARTMENT
GOVT. OF BIHAR

Training Manual

Hands-on Training
on
"Advanced Diagnostic and Therapeutic Techniques in Veterinary Practices"

(18-22 August, 2025)

Directorate of Extension Education
Bihar Animal Sciences University, Patna-14


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Sponsored by:

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Bihar Animal Sciences University, Patna-14

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Message

It gives me great pride to present this training manual titled; *Hands-on Training on Advanced Diagnostic and Therapeutic Techniques in Veterinary Practices*, prepared for the Veterinary Officers of Bihar. This manual embodies the university's ongoing commitment to strengthening the field-level capacity of veterinary professionals by equipping them with practical skills that align with the dynamic needs of animal health and production systems.

The livestock sector is central to ensuring nutritional security and sustaining rural livelihoods in Bihar. In recent years, rapid developments in diagnostics, therapeutics, and disease management have transformed veterinary practices. It is therefore essential that our Veterinary Officers are equipped with updated knowledge, advanced techniques, and modern tools to effectively address field challenges and deliver quality services to farmers.

This manual has been thoughtfully developed by experienced faculty members and subject experts of Bihar Animal Sciences University to provide both structured training and practical reference material. I am confident that this initiative will enhance the clinical competence of our veterinary officers and contribute significantly to improving livestock health and productivity in the state.

I convey my sincere appreciation to the organizing team, contributors, and resource persons for their dedicated efforts in preparing this valuable resource. I extend my best wishes to all participants for a fruitful and enriching learning experience.

Dr. Inderjeet Singh
Vice Chancellor, BASU, Patna

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Message

It gives me immense pleasure to present this training manual entitled **Hands-on Training on "Advanced Diagnostic and Therapeutic Techniques in Veterinary Practices"** prepared for the veterinary officers of Bihar. This manual is a part of the university's ongoing commitment to strengthening the field-level capacities of veterinary professionals through skill-based, practical training aligned with the current demands of animal health and production systems.

There has been significant advancements in recent years, particularly in the domains of diagnostics, therapeutics, and disease management. The livestock sector in Bihar plays a crucial role in ensuring nutritional security and rural livelihoods. Therefore, it is imperative that our veterinary officers are well-equipped with the latest techniques, tools, and approaches in clinical diagnosis and treatment. This training program is specifically designed to provide **hands-on exposure to advanced diagnostic procedures, clinical interpretation, therapeutic interventions, and critical care protocols** relevant to field conditions.

This manual will serve as both a **training guide and a practical reference**, enabling officers to enhance their professional competence and offer improved veterinary services to farmers. The content has been thoughtfully curated by experienced faculty members and domain experts of Bihar Animal Sciences University, keeping in mind the real-world challenges faced in rural veterinary practice.

I extend my sincere appreciation to the organizing team, resource persons, and contributors who have worked diligently to develop this valuable resource. I am confident that the training, along with this manual, will significantly enhance the clinical acumen of our veterinary officers and contribute meaningfully to the health and productivity of livestock in Bihar.

I wish all the participants a fruitful and enriching training experience.

Dr. Nirmal Singh Dahiya
DEE, BASU, Patna

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Extension Services and Programs of the Directorate of Extension Education, BASU, Patna

Y.S. Jadoun, Nirmal Singh Dahiya and A.K. Thakur
Directorate of Extension Education (DEE)
Bihar Animal Sciences University (BASU), Patna

The **Directorate of Extension Education (DEE)** at **Bihar Animal Sciences University (BASU), Patna**, serves as a vital bridge connecting cutting-edge research and innovations developed within the university to the practical needs of farmers across Bihar. Its core mandate is to facilitate the **transfer of scientific knowledge and proven technologies** related to animal husbandry and veterinary sciences directly to livestock owners, rural youth, and other stakeholders involved in the livestock sector.

To fulfil this mission, the directorate undertakes a wide array of **farmer-centric extension activities**, including **capacity-building programs, on-farm demonstrations, village adoption models, mobile veterinary services, BASU Krishi Gyan Vahan, awareness campaigns, and digital outreach initiatives**. These programs are designed to promote best practices in areas such as **livestock health management, breeding, nutrition, fodder production, disease prevention**, and **value-added animal products**.

By engaging with farmers through both physical and digital platforms, the Directorate ensures that the latest innovations and scientific interventions reach the grassroots level, thereby contributing to improved productivity, better animal welfare, and enhanced rural livelihoods. The major extension activities carried out by the Directorate of Extension Education are outlined below.

Farmer Training Programs

Conducts regular **on-campus and off-campus trainings** for farmers, livestock keepers, veterinary officers, dairy field officers, livestock assistants, and rural youth. Such as:

- Dairy farming and milk processing
- Diagnostic and therapeutic techniques in veterinary practices
- Goat and poultry farming
- Fodder production and silage making
- Clean milk production

- Animal health and vaccination

Field-Level Demonstrations and Farmer Interface

a) FLDs and OFTs

Frontline Demonstrations (FLDs) and On-Farm Trials (OFTs) to evaluate and popularize livestock technologies across farming systems.

b) Demonstration Units at KVK, Jamui

The Directorate of Extension Education (DEE), Bihar Animal Sciences University (BASU), Patna, has taken a significant step towards strengthening practical agricultural education and skill development by establishing multiple demonstration units at the newly established Krishi Vigyan Kendra (KVK) in Jamui. These include dedicated units f**or goat, poultry, pig, and cattle rearing, offering vital hands-on training and experiential learning** opportunities to farmers, students, and extension workers.

In addition to livestock units, DEE has also developed essential infrastructure to support comprehensive agricultural extension activities. A nursery demonstration unit has been set up to promote horticultural practices and plant propagation techniques. Two functional borewells have been installed to ensure a reliable water supply for farm operations and irrigation needs. Furthermore, a farm implement shed has been constructed to house agricultural tools and machinery, enabling mechanized demonstrations and equipment familiarization.

To provide continuous support and advisory services to the farming community, a **Kisan Paramarsh Kendra (Farmers' Advisory Center)** has been established. This center serves as a hub for information dissemination, farmer-scientist interactions, and on-the-spot solutions to agricultural challenges. Moreover, a seed production unit has been initiated to facilitate the production and distribution of quality seeds, contributing to improved crop productivity and sustainability in the region.

These developments at KVK Jamui underscore BASU's commitment to integrated, field-livestock based agricultural education and its vision of empowering rural communities through science-led integrated farming practices.

c) New KVK at Jamui

Directorate of Extension Education (DEE) at **Bihar Animal Sciences University**

(BASU), Patna is instrumental in establishing a new KVK, extending the university's presence and outreach in tribal and underdeveloped regions.

Animal Health and Awareness Camps: Organizes **free veterinary health camps** in remote and rural areas.

Services include:

- Vaccination
- Deworming
- Disease diagnosis and treatment
- Infertility and reproductive disorder treatments

Also conducts awareness campaigns on zoonotic diseases and hygienic livestock practices.

Farmer-Scientist Interaction Programs: Arranges interactive sessions between university experts and local farmers.

Aims to:

- Solve field-level livestock problems
- Collect feedback for research and extension improvements
- Promote collaborative learning and experience sharing

Collaboration and Networking

Directorate of Extension Education, Bihar Animal Sciences University (BASU), Patna have strong collaboration, linkages and networking with

- BAMETI
- Animal and Fisheries Resources Department (AFRD), Bihar
- NABARD
- COMFED
- JEEViKA
- Bihar Livestock Development Agency (BLDA)
- ICAR-RCER & ICAR-ATARI
- National Commission for Women (NCW), New Delhi
- Dairy Development Department, Bihar

These linkages have facilitated joint training programs, funding, innovation dissemination, and field demonstrations.

Information, Education, and Communication (IEC) Activities
Publication and Distribution of Extension Literature

- Publishes leaflets, booklets, manuals, and newsletters in regional languages for easy understanding.
- Topics include disease management, fodder production, breeding techniques, and value-added dairy products.

Audio-Visual Aids

- Produces educational videos and slide presentations on animal husbandry practices.
- Broadcasts programs through Doordarshan, All India Radio, and local cable networks.

Use of ICT Tools

- Provides information through mobile apps, SMS services, and WhatsApp groups.
- Maintains an online knowledge updates on livestock management at University website

Organization of Exhibitions, Fairs, and Events;
Livestock and Agriculture Fairs (Pashu Melas)

- Hosts exhibitions to showcase latest technologies, breeds, and innovations.
- Offers platform for farmers to interact with scientists and companies.

World Veterinary Day, World Milk Day, and Other Celebrations

- Organizes events to spread awareness on livestock health, nutrition, and productivity.
- Involves school children, farmers, and stakeholders for community participation.

Participation in State/National Exhibitions

- Represents BASU in regional and national agri expos and fairs.
- Demonstrates university innovations and farmer success stories.

Flagship Programs and Initiatives Directorate of Extension Education

Directorate of Extension Education (DEE) at **Bihar Animal Sciences University (BASU), Patna**, implemented numerous innovative extension programs aimed at bridging the gap between research and client system of livestock farmers of the state.

a) Cattle Expo-2023

Organized Bihar's landmark Cattle Expo, promoting livestock technologies, breed improvement, and farmer-scientist interaction.

b) Pashupalan Darshika – Hindi Magazine

To strengthen knowledge dissemination among livestock farmers and rural communities, a Hindi magazine titled **'Pashupalan Darshika'** has been launched as a **quarterly** publication. This magazine is specifically designed to cater to the informational needs of Bihar's rural population, with a focus on promoting best practices in animal husbandry, veterinary care, livestock management, and allied agricultural activities.

'Pashupalan Darshika' serves as an accessible and practical resource, offering expert insights, success stories, seasonal advisories, and scientific recommendations in a language that is both familiar and easy to understand for farmers. The publication aims to bridge the gap between research institutions and the grassroots level by translating technical knowledge into actionable guidance. By empowering farmers with up-to-date and relevant information, the magazine contributes significantly to improving livestock productivity, health, and income generation in rural Bihar.

This initiative reflects a broader commitment to inclusive extension services and the use of regional languages as a medium to enhance outreach and impact across farming communities.

c) e-Kisan Samadhan

A digital initiative leveraging WhatsApp groups for quick advisory delivery, real-time interaction with farmers, and dissemination of weather, disease alerts.

e-Kisan Samadhan is a digital extension initiative launched by the **Directorate of Extension Education, Bihar Animal Sciences University (BASU), Patna**, designed to provide real-time, science-based livestock advisory services to farmers through modern communication tools. The program primarily operates through **WhatsApp groups**, making it easily accessible even to farmers in remote and rural areas. It leverages **live interactive webinars**, expert-led audio-visual sessions, and

regular **video uploads** on dedicated platforms to disseminate practical knowledge related to **animal health care, nutrition, breeding, disease prevention, and scientific livestock management**.

Through this initiative, farmers receive timely solutions to their field-level challenges directly from veterinary and animal husbandry experts. The platform also facilitates two-way communication, allowing farmers to ask questions, share field observations, and adopt improved practices based on expert feedback. By combining digital technology with expert outreach, **e-Kisan Samadhan** plays a vital role in **empowering livestock farmers and rural youth**, enhancing productivity, and promoting sustainable livestock-based livelihoods. It stands as a model for **inclusive, ICT-driven agricultural extension**, effectively bridging the gap between research institutions and grassroots communities.

d) BASU Krishi Gyan Vahan: A Mobile Knowledge Dissemination Initiative

Directorate of Extension Education (DEE), Bihar Animal Sciences University (BASU), Patna has started a unique initiative **"Krishi Gyan Vahan"**, under 4th Krishi Road Map, Govt. of Bihar, a mobile extension, and outreach service aimed at bridging the knowledge gap between researchers, extension personnel, and farmers across Bihar. This initiative plays a crucial role in technology dissemination, awareness creation, and capacity building among livestock and crop farmers, particularly in remote and underserved regions.

The **Krishi Gyan Vahan** is a well-equipped vehicle carrying:

- Audio-visual aids (TV, PA system, projector)
- Training materials, leaflets, and brochures
- Models and samples for demonstration
- Veterinary medicines and diagnostic kits

Teams comprising **BASU scientists**, **veterinary officers**, and **subject matter specialists (SMSs)** from **KVKs** accompany the van during field visits. The Vahan follows a pre-determined schedule covering different blocks and panchayats, in collaboration with the **AFRD**, **KVKs and ATMA**, and other allied departments.

e) Village Adoption Program

Adopted Dariyapur Village of Naubatpur block Patna under a participatory rural extension model focused on dairy and poultry development, with the objective of transforming it into a model village. The initiative aimed at holistic livestock

development, creating a cascading impact in nearby areas by enhancing income levels and generating employment opportunities.

Conclusion

The Directorate of Extension Education at Bihar Animal Sciences University (BASU), Patna, serves as a pivotal force in advancing the university's outreach mission. It plays a crucial role in bridging the gap between scientific research and grassroots application by effectively disseminating knowledge and best practices to farming communities across Bihar. Through a multifaceted approach that includes farmer training programs, awareness campaigns, on-field demonstrations, and collaborative initiatives with governmental and non-governmental organizations, the directorate has made substantial contributions to enhancing the productivity, profitability, and sustainability of livestock farming in the region.

By aligning its activities with emerging technologies and the evolving needs of rural stakeholders, the directorate remains committed to promoting innovation and resilience in the livestock sector. Its dynamic and adaptive strategies not only empower farmers with practical skills and scientific knowledge but also foster a culture of continuous learning and self-reliance.

Principles and Practice of Fluid Therapy in Veterinary Medicine

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Fluid therapy forms a cornerstone of veterinary clinical practice, serving as a life-saving intervention in a wide range of conditions. It is indispensable for restoring and maintaining fluid balance, correcting acid-base and electrolyte imbalances, supporting adequate tissue perfusion, and acting as a medium for delivering medications. In clinical settings, animals often present with varying degrees of dehydration or fluid shifts resulting from trauma, surgical interventions, gastrointestinal disturbances, renal dysfunction, or systemic infections. These conditions can lead to compromised circulation, shock, or multi-organ dysfunction if not managed promptly. Timely and accurate fluid administration—tailored to the type and extent of the fluid loss—is critical in stabilizing patients, improving prognosis, and expediting recovery. Whether employed in emergency resuscitation, perioperative care, or chronic disease management, fluid therapy remains one of the most frequently employed and effective tools in veterinary medicine.

Body Water Distribution and Physiology

Water is the most abundant component in an animal's body, accounting for approximately 60% of total body weight. This total body water is distributed between two primary compartments: intracellular fluid (ICF) and extracellular fluid (ECF). About two-thirds of the total water resides within cells (ICF), where it is essential for maintaining cellular metabolism and biochemical functions. The remaining one-third is located in the ECF, which is further subdivided into the interstitial fluid (three-fourths of ECF) and intravascular fluid or plasma (one-fourth of ECF). This division is critical because the fluid in the intravascular space directly influences blood volume and pressure, while the interstitial fluid serves as the medium through which nutrients, waste products, and gases are exchanged between the blood and cells. Fluid movement between these compartments occurs freely due to the permeability of cell and capillary membranes to water. However, the movement is primarily governed by osmotic gradients created by solute concentrations, particularly electrolytes and plasma proteins. Osmotic pressure and hydrostatic pressure are key forces that regulate fluid exchange, ensuring equilibrium across compartments. Understanding this distribution is crucial in veterinary fluid therapy, as it guides appropriate fluid

selection and volume replacement strategies for restoring physiological balance.

Indications for Fluid Therapy

- Correction of dehydration and hypovolemia
- Management of acid-base and electrolyte imbalances
- Supportive therapy for renal dysfunction
- Drug delivery via constant-rate infusions (CRI)
- Maintenance during perioperative periods
- Inducing diuresis in cases of toxicosis

Types and Classification of Dehydration

Dehydration refers to the loss of body water along with essential electrolytes, resulting in an imbalance in the fluid compartments of the body. It is a common clinical condition encountered in veterinary practice, often secondary to gastrointestinal diseases, renal dysfunction, or systemic illness. Based on the relative loss of water and electrolytes, dehydration is broadly classified into three types: isotonic, hypotonic, and hypertonic. Each type has distinct pathophysiological features and requires tailored fluid therapy for effective correction.

Isotonic Dehydration

This is the most encountered form of dehydration in animals. It involves a proportional loss of water and electrolytes, primarily sodium and chloride, resulting in no significant change in plasma osmolality. Common causes include vomiting, diarrhea, polyuria, and hemorrhage. Because the osmotic balance between intracellular and extracellular compartments remains unchanged, water does not shift significantly between them. However, the loss of extracellular fluid (ECF) volume can compromise perfusion, leading to signs such as decreased skin turgor, prolonged capillary refill time (CRT), dry mucous membranes, and tachycardia. Isotonic crystalloid solutions like Lactated Ringer's Solution or Normal Saline are typically used to correct this type of dehydration.

Hypotonic Dehydration

In hypotonic dehydration, the loss of electrolytes, especially sodium, exceeds the loss of water. This results in decreased plasma osmolality, leading to a net movement of water from the extracellular space into the intracellular space, causing cellular swelling. This condition is commonly seen in cases of secretory diarrhea caused by pathogens like Escherichia coli or Salmonella, as well as in conditions such as pyloric stenosis and gastric dilatation-volvulus. Clinical signs may include lethargy, muscle

weakness, and in severe cases, neurological manifestations due to cerebral edema. Treatment involves administering isotonic or mildly hypertonic fluids, often supplemented with sodium, to restore osmotic balance and correct the deficit.

Hypertonic Dehydration

This type results from a greater loss of water than electrolytes, causing increased plasma osmolality. Water shifts from the intracellular to the extracellular space in an attempt to restore osmotic balance, leading to cellular dehydration. Conditions such as diabetes insipidus, inadequate water intake, and excessive panting or fever commonly cause hypertonic dehydration. Affected animals may exhibit marked thirst, dry mucous membranes, and signs of neurological dysfunction like ataxia and seizures. Rapid correction with hypotonic fluids should be avoided due to the risk of cerebral edema; instead, gradual rehydration using isotonic or slightly hypotonic solutions is preferred.

Clinical Signs

Recognizing the clinical signs of dehydration is critical for timely diagnosis and appropriate fluid therapy. Dehydration in animals is assessed by estimating the percentage of total body water lost, with severity ranging from mild and subclinical to life-threatening. When dehydration is less than 5%, clinical signs are often absent or very subtle, making it difficult to detect without laboratory testing. At 5–6%, signs such as tacky (sticky) mucous membranes and a slight delay in skin tenting may be observed, indicating mild dehydration. Moderate dehydration (7–8%) is characterized by more obvious clinical signs, including dry mucous membranes, sunken eyes, prolonged capillary refill time (CRT of 2–3 seconds), and decreased skin elasticity. In severe cases (10–12%), signs include markedly sunken eyes, cold extremities, CRT exceeding 3 seconds, severe skin tenting, and signs of circulatory collapse or early shock. Dehydration exceeding 12–15% is critical and often results in hypovolemic shock, collapse, and death if not immediately corrected. Consistent evaluation of mucous membrane moisture, CRT, skin turgor, eye position, and general demeanor is essential in assessing dehydration severity and guiding fluid therapy.

Diagnostic Evaluation

- Laboratory values aid in diagnosing and grading dehydration:
- PCV & Total Protein: Increased in dehydration
- Serum electrolytes: Guide specific replacement therapy
- BUN/Creatinine: Elevated in pre-renal azotemia

- USG (Urine SG): >1.030 suggests renal response to dehydration

Types of Fluids

Fluid therapy in veterinary medicine relies on two major categories of fluids: crystalloids and colloids. The choice depends on the type and severity of dehydration, the underlying disease condition, and the therapeutic goal, whether it is volume expansion, maintenance, or correction of electrolyte or acid-base imbalances.

A. Crystalloids

Crystalloids are water-based solutions containing small molecules such as electrolytes and sugars that can easily cross capillary membranes. They are the most used fluids in veterinary practice due to their affordability and broad applicability.

1.IsotonicCrystalloids

These solutions have osmolality similar to plasma and are ideal for rehydration, electrolyte correction, and general fluid replacement.

0.9% Normal Saline (NaCl): Sodium-rich; lacks potassium and calcium. Used in cases of vomiting, diarrhea, and metabolic alkalosis.

Lactated Ringer's Solution (LRS): Contains sodium, potassium, calcium, chloride, and lactate (a buffer). Suitable for treating metabolic acidosis and general fluid loss.

Ringer's Solution: Similar to LRS but without lactate; preferred in large animals that are prone to alkalosis.

Normosol-R and Plasmalyte: Balanced electrolyte solutions; good for perioperative and critical care patients.

Dosage (dogs/cats/cattle)

Maintenance: 40–60 ml/kg/day

Replacement: Depends on % dehydration (e.g., 10% dehydration in a 25 kg dog = 2500 ml over 24 hrs)

Shock Dose: Dogs – up to 90 ml/kg/hr; Cats – 50–60 ml/kg/hr

2. Hypotonic Crystalloids

5% Dextrose in Water (D5W): Provides free water, not suitable for volume expansion. Used to manage hypoglycemia, especially in neonates or septic patients.

3. Hypertonic Crystalloids

3–7.5% Hypertonic Saline: Draws fluid from interstitial and intracellular compartments into the vascular space. Rapidly improves blood pressure in cases of hypovolemic or endotoxic shock.

Dosage: 4–5 ml/kg IV over 5–10 minutes (dogs, cattle); must be followed by isotonic crystalloids to maintain fluid balance.

B. Colloids

Colloids are fluids containing large molecules that remain within the vascular compartment, making them ideal for maintaining oncotic pressure and plasma volume in hypoproteinemic or hypotensive animals.

1. Natural Colloids

Whole Blood: Used in hemorrhagic shock or severe anemia.
Plasma: Corrects hypoproteinemia and coagulopathies.
Packed RBCs: Indicated in anemic but normovolemic animals.
Dosage:
Whole Blood: 10–20 ml/kg IV
Plasma: 10–15 ml/kg IV
Packed RBCs: 1 unit/10–20 kg body weight

2. Synthetic Colloids

Hetastarch (e.g., Vetplasma), Dextrans: Effective in maintaining blood pressure during shock and severe hypoalbuminemia. They provide rapid plasma volume expansion and are often used in combination with crystalloids.
Dosage
Dogs: 5–10 ml/kg IV over 15–30 minutes
Cattle: 8–10 ml/kg IV
Small animals: 10–20 ml/kg/day, adjusted based on CVP and hydration status
In all cases, fluid therapy must be carefully monitored to prevent complications like fluid overload, pulmonary edema, or electrolyte disturbances. Regular reassessment of clinical and laboratory parameters is vital for ensuring safe and effective treatment. Choosing the appropriate fluid type is a critical step in effective fluid therapy, as it directly impacts the correction of underlying physiological disturbances. The decision should be based on a thorough clinical assessment of the animal, supported by laboratory data. Several factors must be considered, including the type and extent of fluid loss, electrolyte imbalances, acid-base status, and the specific pathophysiology of the disease involved.

Fluid Selection Based on Clinical Condition

The nature of fluid loss, whether isotonic, hypotonic, or hypertonic—plays a central role in fluid selection. For isotonic dehydration, isotonic crystalloids such as Lactated Ringer's Solution (LRS) or Normal Saline (0.9% NaCl) are typically used. In cases of

acidosis, LRS is preferred due to its lactate content, which serves as a buffer and is converted into bicarbonate by the liver. Conversely, in patients with metabolic alkalosis, Ringer's Solution (which lacks lactate) is more suitable, particularly in large animals prone to alkalosis. Hypertonic saline is used in emergency situations such as shock to rapidly expand plasma volume, but it must be followed by isotonic fluids to prevent rebound dehydration.

Electrolyte-Based Fluid Modification

Electrolyte supplementation is often necessary to tailor the fluid therapy to the patient's needs.

Potassium (K): Hypokalemia is defined as serum K levels below 3.5 mEq/L and is commonly associated with prolonged anorexia, diarrhea, or diuretic use. Potassium chloride can be added to fluids cautiously (not exceeding 0.5 mEq/kg/hr) to correct the deficit.

Bicarbonate (HCO): Indicated in metabolic acidosis, often seen in severe diarrhea or renal failure. The bicarbonate requirement is calculated using the base deficit **formula:**

HCO needed (mEq) = Base Deficit × 0.3 × Body Weight (kg).

Overcorrection should be avoided as it may lead to alkalosis and neurologic complications.

Dextrose: Used in cases of hypoglycemia, liver disease, sepsis, or neonatal weakness. A 5% dextrose solution can maintain normoglycemia, while 50% dextrose diluted appropriately is used for acute correction.

Calcium (Ca^2): Hypocalcemia may occur in parturient paresis or sepsis. Calcium gluconate is commonly administered slowly IV while monitoring cardiac function.

Appropriate fluid selection and supplementation not only restore fluid balance but also correct metabolic derangements, support organ function, and improve clinical outcomes. Regular monitoring of clinical signs, urine output, and laboratory values is essential for adjusting the therapy accordingly.

Routes of Administration

IV: Preferred (jugular, cephalic, saphenous)

Intraosseous: For neonates, rapid access

Intraperitoneal: For young animals (slow absorption)

Subcutaneous: Only for mild dehydration (avoid 5% dextrose)

Fluid Calculation and Therapy Plan

Formula:

Fluid required (ml) = {Body weight (g) × % dehydration} + Estimated ongoing

losses + Maintenance
Maintenance requirement:
{(BW in kg × 30) + 70} ml/day
Example:
25 kg dog, 10% dehydrated = 25000 g × 0.10 = 2500 ml (deficit)
Fluid distribution:
Total Body Water (TBW) loss = 2500 ml
ECF (⅓ of TBW) = ~833 ml
IVF (¼ of ECF) = ~208 ml

Fluid Infusion Rates and Monitoring
Shock Rate (dog): Up to 90 ml/kg/hr with close CVP monitoring
General Protocol:
- 1st hr: 13-14 ml/kg/hr
- 2nd hr: 10 ml/kg/hr
- 3rd hr: 5 ml/kg/hr
- 4th hr onward: 2 ml/kg/hr

Monitor:
- Daily weight
- Lung sounds (for overload)
- CRT, urine output, CVP

Signs of Overhydration:
- Serous nasal discharge
- Crackles, restlessness
- Drop in PCV/TP, increased BP

Fluid Therapy in Specific Conditions
Fluid therapy plays a vital role in the management of various disease-specific conditions in animals by restoring and maintaining circulatory volume, correcting electrolyte and acid-base imbalances, and supporting organ function. In conditions such as shock, diarrhea, vomiting, ketosis, and renal dysfunction, timely and tailored fluid administration can be lifesaving. The type, volume, and rate of fluids must be carefully chosen based on the pathophysiology of the disease, species involved, and clinical status of the patient. Accurate fluid therapy not only improves recovery and survival rates but also enhances the effectiveness of concurrent treatments.

This table summarizes fluid therapy recommendations across various disease conditions in dogs, cats, and cattle, including appropriate fluid types and dose rates. It

is designed to aid clinical decision-making in common scenarios.

Condition	Species	Fluid Choice	Dose Rate	Notes
Ketosis	Cattle	5–10% Dextrose IV + oral propylene glycol	500–1000 ml IV over 30–60 min daily	Common post-partum; combine with energy sources
	Dogs/Cats	0.9% NaCl → 0.45% NaCl + 2.5–5% Dextrose	10–20 ml/kg/hr	For diabetic ketoacidosis (DKA)
Vomiting	Dogs/Cats	LRS or 0.9% NaCl + KCl	Maintenance + deficits + ongoing loss	Monitor electrolytes, esp. K
	Cattle	0.9% NaCl ± KCl ± Calcium	40–80 ml/kg IV	Often metabolic alkalosis due to reflux
Diarrhea	Dogs/Cats	LRS + KCl ± bicarbonate	Based on % dehydration + losses	Commonly causes metabolic acidosis
	Calves	Oral fluids (mild), IV isotonic bicarbonate or LRS + glucose	80–100 ml/kg IV over 4–6 hr	Assess acidosis; add glucose for energy
Cerebral Edema	Dogs/Cats	Hypertonic saline (3%) or Mannitol	4–5 ml/kg hypertonic saline or 1–2 g/kg Mannitol IV	Avoid hypotonic fluids (e.g., D5W)
Meningitis	Dogs/Cats	Isotonic crystalloids (LRS, Normosol-R)	40–60 ml/kg/day (maintenance)	Monitor neurologic status
	Calves	LRS + glucose + antibiotics	60–100 ml/kg IV over 6–8 hr	Supportive + antimicrobial therapy
Fever	Dogs/Cats	LRS or Plasmalyte	Maintenance + 10–20% extra per °C rise	Compensate for insensible fluid loss
	Cattle	Ringer's or Normal saline	Add 4.5–5 L/day per 1°F (0.55°C) temp increase	Adjust total fluid intake accordingly
Jaundice	Dogs/Cats	LRS or 0.9% NaCl (avoid lactate in severe liver dysfunction)	Maintenance rate (40–60 ml/kg/day)	Supportive; monitor liver enzymes and hydration
Hepatitis	Dogs/Cats	0.9% NaCl ± glucose ± potassium	Maintenance + correction of deficits	Avoid lactate-containing fluids in severe hepatic disease
Renal Failure (Acute)	Dogs/Cats	0.9% NaCl, Plasmalyte, Normosol-R	60–90 ml/kg/day or based on urine output	Monitor BUN, creatinine, and electrolytes closely
Renal Failure (Chronic)	Dogs/Cats	Subcutaneous LRS or Normosol-R	10–20 ml/kg/day SC	Used for long-term maintenance at home
Ascites	Dogs/Cats	0.9% NaCl ± colloids (Hetastarch)	Maintenance only, avoid aggressive boluses	Cautious use to prevent worsening effusion
Congestive Heart Failure	Dogs/Cats	Restricted fluids, low sodium (¼ strength saline)	2–4 ml/kg/hr IV or < maintenance	Monitor for pulmonary edema; avoid overload
Anemia	Dogs/Cats	Whole blood or packed RBCs	10–20 ml/kg IV over 1–2 hrs	Corrects oxygen-carrying capacity in severe cases
Pancreatitis	Dogs/Cats	LRS or Normosol-R + KCl	Maintenance + ongoing loss (60–90 ml/kg/day)	Avoid fatty emulsions; correct electrolyte losses

Conclusion

Fluid therapy is an indispensable tool in veterinary clinical practice, providing critical support in a wide range of disease conditions—from dehydration, shock, and renal failure to systemic infections, hepatic dysfunction, and cardiac disorders. Its

effectiveness lies in the accurate assessment of fluid deficits, electrolyte imbalances, and the underlying pathophysiology of the disease. Tailoring fluid type, volume, and administration route to the specific needs of each patient-whether a calf with diarrhea, a cat with renal disease, or a dog with pancreatitis-ensures optimal therapeutic outcomes. Close monitoring during therapy, including hydration status, urine output, cardiovascular and respiratory parameters, is essential to prevent complications such as fluid overload or electrolyte disturbances. Mastery of fluid therapy principles significantly improves survival, accelerates recovery, and enhances the overall standard of veterinary care.

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Basic Principles of Radiography

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Radiography is a commonly used diagnostic tool in veterinary practice. X-ray images (radiographs) allow radiologists and other specialists to examine the body for injury or disease. Not only used for bones, radiographs also provide examination of the heart, lungs, and abdominal organs. Radiography is often the first line of diagnostic imaging with which a radiologist can either make a diagnosis, or direct the need for further imaging. It is quick, painless, and economical tools of diagnostic imaging.

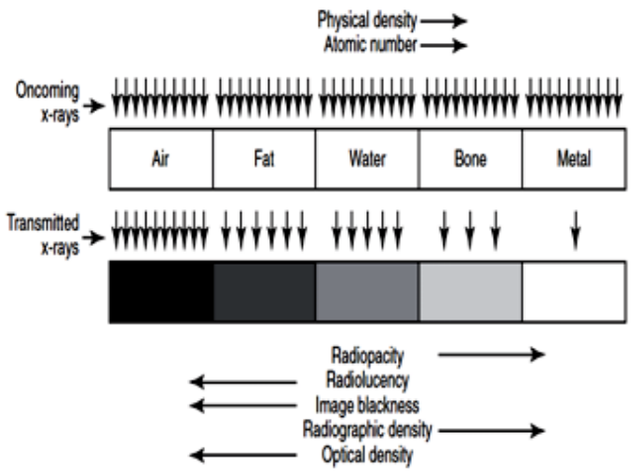
X-ray machines
Variety of X-ray machines are now a days available in veterinary field. They can be of following types.

Mobile/Portable X-ray machines
These are low voltage x-ray machines (70-150 mA) and are used for making radiographs of extremities of animals i.e. bones below carpus or tarsus joints. Commonly used in veterinary field and are portable ones.

Ceiling suspension X-ray machines
These are high voltage X-ray machines (300-1000 mA) and are generally used for large animal radiography. With these machines radiography of abdomen and chest is possible but these needs setting up of very high exposure factors.

Moving Grid X-ray machines
They are generally used for radiography of dogs, cats and small ruminants.

Radiographic Density
Radiographic density is the measure of the degree of blackness on a processed film and is directly related to the number of X rays reaching the film. More the number of X-rays that reach the film, blacker it is i.e. higher is the radiographic density. Radiographic density is inversely proportional to the subject density as denser the object more it absorb s X-rays so that less photons reach the film. Main densities which can be appreciated on a radiograph are i) metal, mineral and bone, ii) fluid (soft tissue), iii) fat, and iv) gas



Interpreting Abdominal Radiographs

Some important radiographic features of disorders involving various structures are described below.

Diaphragm

The diaphragm should be evaluated for its integrity. In case of diaphragmatic hernia, the abdominal viscera can be visualized in the thoracic cavity across the diaphragm.

Liver and Gall Bladder

Diffuse

Hepatomegaly in dogs may be evaluated by assessing the axis of the stomach. In most dogs, the long axis of stomach is parallel to the rib cage on lateral view. Generalized enlargement of the liver produces characteristic displacement of the pylorus and pyloric antrum caudally, dorsally, and to the left. In many instances the enlarged caudoventral edge of the abnormal liver can be seen as it projects beyond the costal margin.

Spleen

On a lateral radiograph the tail of spleen in dogs is seen in the ventral abdomen dorsal to the falciform fat and caudal to the stomach at about the level of the umbilicus. It is less commonly seen on lateral radiographs of cats. Spleen should be considered enlarged if its edges are round and displaces adjacent viscera.

Stomach

Normal canine stomach lies transversely across the abdomen with the fundus located on the left side of the midline on VD radiograph and in a cranio-dorsal position on lateral radiograph. Pyloric antrum is located to the right of midline on VD view and ventrally on the lateral view.Acute Gastric Dilation and Volvulus (GDV) can be easily diagnosed on a lateral projection with classical radiographic feature of compartmentalization of stomach or "double bubble appearance" which can be appreciated on lateral and VD views.

Small Intestine

Normalserosal margins should be smooth and are most easily seen adjacent to the abdominal wall, where there is less superimposition of other structures. Young and emaciated animals have poor serosal definition owing to lack of intra-abdominalfat.Normal small bowel diameter should not exceed the height of the central part of the body of a lumbar vertebra or the diameter of the SI in dogs should not be more than 1.6 times the height of the center of the 5th lumbar vertebra.

Cecum

Cecum is located to the right of midline at the level of L2 and L3 on the VD radiographs, with a characteristic gas distended 'C' shape, spiral or comma shape.

Colon

The ascending, transverse and descending colon can be easily identified on the VD projections. Megacolon is diagnosed of the diameter of colon exceeds the length of L7 vertebra.

Urinary Bladder

The commonest abnormality identified in the bladder on plain radiographs are radiopaque calculi. The prostate lies immediately caudal to the neck of the bladder. In young dogs the prostate is located within the pelvic canal. As the dog ages the prostate will tend to be located further cranially. The same cranial displacement also occurs with enlargement of the prostate. The most reliable assessment of the dimensions of the prostate are the transverse diameter should be no greater than 75% of the distance from the ventral surface of the sacrum to the floor of the pelvis.

Kidney

In the dog the normal size of kidney is 2.5-3.5 times the length of the second lumbar vertebra. In cats it is 2-3 times the size of L2. Focal increases in sizes or changes of shape of the kidney are typically associated with either abscess or a neoplastic process.

Reproductive Tract

Enlargement of the uterus is associated with either pregnancy or pyometra. The radiographic differentiation of early pregnancy and pyometra can be difficult. The presence of mineralized fetal parts is the most helpful radiographic sign in determining pregnancy. Mineralization of the fetal skeleton begins at approximately forty to forty five days and is not complete until immediately prior to the term. Fetal death leads to putrefaction and presence of gas in fetus and uterus (visible after 24 hours of death). In pyometra the enlargement of the uterus can become very extensive.

Interpretation of thoracic radiographs

At least three well-positioned orthogonal radiographic views i.e left lateral, right lateral and a DV or VD view are essential for complete evaluation of the thoracic structures. Most radiologists describe radiographic changes within the lung tissue on the basis of lung patterns. There are 4 major categories of lung pattern - these correspond to the component of the pulmonary tissue that is altered. The 4 major categories are:

Interstitial Lung Patterns

The interstitial lung pattern may be nodular or military. In Miliary interstitial pattern there are fine dotted (bread mould) pattern in the lungs (e.g. Blastomycosis). The nodular lung pattern may be structured or unstructured. Structured nodular pattern shows increased nodular densities having distinct, well-defined margins (e.g., neoplasia, chronic granulomas).

Alveolar Lung Pattern

The alveolar pattern may be localized or diffused. May involve a single lung lobe (Lobar sign) or multiple lung lobes. Characteristic findings may include air bronchograms, loss of cardiac silhouette and silhouetting of the pulmonary vasculature and Patchy, poorly defined, increased densities with fluffy, indistinct margins which tend to coalesce.

Bronchial Lung Pattern

The bronchial lung pattern is defined by increased visualization of the bronchi walls. Increased bronchial visualization may be present because of bronchial wall calcification, bronchial wall thickening or the accumulation of peribronchial infiltrates. The bronchial walls seen side-on are linear and parallel. For this reason, the side-on bronchi are commonly referred to as "tram-lines" or "train-tracks". The end-on bronchi appear as circular structures with a radiolucent centre and referred to as "doughnuts".

Vascular Lung Pattern

A vascular pattern is present when the amount of blood in the larger arterial or venous branches is increased or decreased. This causes the vessels to change in size, shape and direction. On a VD/DV view the caudal pulmonary vessels are compared to the 9th rib at the point where they cross this rib. In normal animals the vessels should never be of greater width than the rib. On a Lateral view the cranial pulmonary artery and veins are compared with each other and should be of equal width. Any alteration is indicative of disease process. The width of the vessels on this view should not be greater than the width of proximal third of the 4th rib.

Radiographic assessment of the heart

On lateral radiograph (Right lateral or Left lateral) of the canine thorax, the heart is oriented at approximately 45 degree angle, is situated between the 3rd-8th thoracic vertebrae, and occupies about 3 intercostal spaces. In general a rule of thumb states that a normal cardiac silhouette in the dog usually ranges from 2.5 to 3.5 times the width of intercostal spaces. However this also may not be true in the cases. The vertebral heart scale (VHS) is a method for cardiac measurement that compares the dimensions of the cardiac silhouette with the length of thoracic vertebral bodies. The generic normal range is 8.7-10.7. VHS measurements tend to increase in dogs with cardiac disease. In cats the VHS critical limit is set at 8.5.

Ultrasonography in Small Animals

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Ultrasonography is a non-invasive diagnostic imaging technique that uses high-frequency sound waves to visualize internal body structures in real-time. In small animal practice, especially for dogs and cats, ultrasonography has become an indispensable tool for clinicians due to its safety, repeatability, and ability to provide detailed anatomical and functional information.The application of ultrasonography in companion animals began gaining popularity in the late 20th century, paralleling advancements in veterinary diagnostic imaging. It is now routinely used for evaluating abdominal organs, thoracic structures (in the absence of air interference), musculoskeletal conditions, and even guiding minimally invasive procedures such as biopsies and fluid aspirations.Ultrasound is particularly valuable in detecting conditions such as pyometra, renal diseases, hepatic abnormalities, splenic tumors, urinary tract obstructions, gastrointestinal disturbances, and pregnancy diagnosis. Echocardiography, a specialized form of ultrasonography, plays a critical role in diagnosing and monitoring cardiac diseases in dogs and cats.

Unlike radiography, ultrasonography does not involve ionizing radiation, making it safer for repeated use, including in pregnant animals. The development of portable and high-resolution ultrasound machines has further expanded its accessibility in first-opinion practices and emergency settings.As technology continues to evolve, ultrasonography is increasingly being integrated with other modalities such as Doppler imaging and contrast-enhanced studies, enhancing its diagnostic capabilities in veterinary medicine.

Principles of Ultrasonography

Ultrasonography is based on the principle of sound wave reflection. It uses high-frequency sound waves (ultrasound), typically between 2 to 15 MHz, which are emitted by a transducer (probe). These sound waves penetrate the body and interact with different tissues. Depending on the density and composition of the tissue, the sound waves are:

a) Reflected back to the transducer
b) Transmitteddeeper
c) Scattered/absorbed

The transducer receives the returning echoes, and the ultrasound machine processes these signals to create a real-time image of internal structures.

Key principles include

1. Acoustic Impedance

Each tissue has a unique acoustic impedance (resistance to sound wave transmission). The greater the difference in impedance between two tissues, the stronger the reflected echo.

2. Echo Generation

Tissues that reflect many sound waves appear hyperechoic (bright), while those that reflect few appear hypoechoic (dark). Fluid-filled structures (e.g., bladder, cysts) are typically anechoic (black) because sound waves pass through them without reflection.

3. Attenuation

As sound waves travel through tissue, their intensity diminishes due to absorption and scattering. This is called attenuation, and it increases with depth and frequency.

4. Resolution vs. Penetration

High-frequency probes (7–15 MHz) provide better resolution but less penetration—ideal for superficial structures.

Low-frequency probes (2–5 MHz) offer deeper penetration with lower resolution—used for large dogs or deep abdominal organs.

5. Doppler Effect

Doppler ultrasonography utilizes the frequency shift of echoes from moving blood cells to assess blood flow direction and velocity, crucial in cardiovascular evaluation.

6. Real-Time Imaging

The ultrasound machine updates images continuously, allowing dynamic assessment of organ movement, peristalsis, heart function, and fetal viability.

Modes in Ultrasonography

Ultrasonography operates in several modes, each suited for specific diagnostic purposes.

1. A-Mode (Amplitude Mode)

Description: Oldest and simplest form; displays echoes as vertical spikes on a graph.

Application: Rarely used in clinical practice today. Previously used for measuring fat

or eye axial length.

2. B-Mode (Brightness Mode)
Description: Most commonly used mode in veterinary practice. It creates a two-dimensional grayscale image, where each echo is represented by a dot with brightness corresponding to echo intensity.
Application: Abdominal organ evaluation, pregnancy diagnosis, thoracic structures, musculoskeletal assessments, etc.

3. M-Mode (Motion Mode)
Description: Captures motion of a single scan line over time, producing a wave-like graph.
Application: Primarily used in cardiology to assess heart wall and valve motion (e.g., in dogs with mitral valve disease or dilated cardiomyopathy).

4. Doppler Mode
Used to assess blood flow in vessels and heart. It includes several subtypes:
a) Color Doppler
I. Displays blood flow direction and velocity using color (red and blue).
II. Application: Evaluating blood flow in organs or heart.
b) Power Doppler
a) More sensitive than color Doppler; detects low-velocity flows but doesn't show direction.
b) Application: Detecting small or slow-flowing vessels (e.g., in tumors).
c) Pulsed-Wave Doppler
a) Measures flow velocity at a specific location.
b) Application: Quantifying blood flow through heart valves or vessels.
d) Continuous-Wave Doppler
a) Measures high-velocity flow continuously along a line.
b) Application: Useful in assessing severe valvular stenosis or regurgitation.

5. 3D and 4D Modes(Advanced)
a) 3D Mode: Provides volumetric imaging of structures.
b) 4D Mode: Real-time 3D imaging (moving 3D).
c) Application: Rare in routine veterinary practice; may be used in specialized reproductive or cardiac imaging.

Ultrasound Transducers and Their Applications:
Transducers, or probes, are essential components of an ultrasound machine. They

generate and receive high-frequency sound waves. Different types of transducers are used based on frequency, shape, and field of view, depending on the clinical application and body part being examined.

Types of Transducers Used in USG

1. Linear Transducer

Frequency: High (7.5–15 MHz)
Shape: Flat, rectangular surface
Image: Rectangular field of view
Application
Superficial structures (e.g., tendons, lymph nodes)
Small animal abdomen (superficial organs in cats/small dogs)
Mammary gland, thyroid, skin masses
Vascular access and nerve blocks

2. Curvilinear (Convex) Transducer

Frequency: Medium (3.5–8 MHz)
Shape: Curved surface
Image: Sector-shaped field of view (wider than linear)
Application
General abdominal examination in dogs and cats
Pregnancy diagnosis
Liver, kidney, spleen, urinary bladder
Deeper structures in medium to large dogs

3. Microconvex Transducer

Frequency: Medium to high (5–10 MHz)
Shape: Small curved footprint
Image: Small sector image
Application
Ideal for cats and small breed dogs
Intercostal scanning (e.g., echocardiography)
Neonates and pediatric animals
Ocular and cranial imaging

4. Phased Array Transducer

Frequency: Low to medium (2–5 MHz)
Shape: Small square or circular face
Image: Sector (pie-shaped) field of view

Application:
Echocardiography in all breeds
Useful in tight spaces (e.g., between ribs)
Thoracic imaging

5. Endocavitary / Endorectal Transducer
Frequency: High (7–10 MHz)
Shape: Long, narrow probe
Image: Curved or linear
Application
Rectal or vaginal scanning in small animals
Prostate gland evaluation
Reproductive tract in bitches and queens

Patient Preparation and Positioning of Dogs for Ultrasonography
Proper patient preparation and correct positioning are essential for obtaining high-quality and diagnostic ultrasound images. This ensures minimal artifacts, better organ visualization, and accurate interpretation.

I. Patient Preparation
1. Fasting
Duration
8–12 hours prior to abdominal ultrasound
Purpose
Reduces gas in the stomach and intestines, which can interfere with sound wave transmission and image quality.
Note: Fasting is not necessary for emergency cases.

2. Bladder Filling
A moderately full urinary bladder provides better evaluation of the bladder wall and adjacent organs.
Encourage the dog not to urinate for at least 2–3 hours before the exam if urinary tract evaluation is intended.

3. Hair Clipping
The area to be scanned should be liberally clipped to ensure proper contact of the transducer with the skin.

Common clipping sites:

Abdomen: From xiphoid to pubis and laterally to the flanks
Thorax (for cardiac scans): Over the left/right thoracic wall (4th to 6th intercostal space)

4. Coupling Gel
Ultrasound gel can be applied to eliminate air between the transducer and the skin surface for optimal sound wave transmission.

5. Sedation
Usually not required, but mild sedation (e.g., with butorphanol or acepromazine) may be used in anxious, aggressive, or non-cooperative dogs, especially for prolonged or painful evaluations.

II. Patient Positioning
The positioning depends on the organ system being evaluated
1. Abdominal Ultrasonography
The most Common Position is dorsal recumbency (dog lies on back) using a V-trough or foam support. This allows access to entire abdomen, including liver, spleen, kidneys, intestines, and bladder.Alernatively, lateral recumbency(left or right side) can be used in fractious or uncomfortable animals.

2. Echocardiography (Cardiac Ultrasound)
For echocardiography right or left lateral recumbency can be done. Left lateral is commonly used for right parasternal view (standard in veterinary cardiology).A soft table or cut-out "echocardiography table" can be used for probe access from beneath.

3. Thoracic Ultrasonography
For this lateral or sternal recumbency depending on the region of interest can be done.
Application
For pleural effusion, lung consolidation, or mediastinal masses.

Methods of using probe in ultrasonography
In small animal ultrasonography, several probe manipulation techniques are used to obtain optimal images and thoroughly evaluate internal structures.
I. Fanning: It involves pivoting the probe on its fixed point in a sweeping motion to scan through an organ in multiple slices without changing the probe's location.
II. Sliding: It is the movement of the probe linearly across the skin surface to shift from one region to another.

III. Rotating: It means turning the probe clockwise or counterclockwise to change the scanning plane, such as from longitudinal to transverse.

IV. Tilting (or heel-toe maneuver)

It adjusts the angle of the probe by lifting or lowering one end, which helps in visualizing structures at different depths or angles.

V. Rolling

It refers to a gentle rotation along the long axis of the probe to refine image alignment. These techniques are essential for comprehensive and dynamic assessment of organs in dogs and cats, ensuring accurate diagnosis.

Artifacts and their Applications in Ultrasonography (USG)

Artifacts in ultrasonography are image distortions or errors that occur due to the interaction of ultrasound waves with tissues and interfaces in ways not anticipated by standard assumptions. While some artifacts may obscure diagnostic detail, others can be useful in identifying specific conditions or structures. Understanding them is crucial for accurate interpretation.

Common Ultrasound Artifacts and Their Applications

1. Acoustic Shadowing

Description

It appears as a dark band (shadow) distal to a highly reflective or absorptive structure.

Cause

Sound waves are blocked or absorbed (e.g., by bone, calculi).

Application

It is useful in detecting urinary calculi, bone, or gas. Presence of shadow confirms the density of the object.

2. Acoustic Enhancement (Posterior Enhancement)

Description

Increased echogenicity (brightness) behind fluid-filled structures.

Cause

Sound waves pass easily through fluid, leading to stronger echoes from deeper tissues.

Application

It helps to identify cysts, urinary bladder, gallbladder, and uterine fluid in pregnancy.

3. Reverberation Artifact

Description

Multiple equally spaced bright lines appearing due to repeated reflections between strong interfaces.

Cause

Occurs between the probe and a highly reflective surface (e.g., gas or metal).

Application: It Indicates the presence of gas(as in intestines or pneumothorax) or foreign metallic objects.

4. Mirror Image Artifact

Description

A duplicate image of an organ appears on the other side of a strong reflector.

Cause

Sound waves reflect off a curved surface like the diaphragm before returning.

Application

It is seen in hepatic imaging, may help identify diaphragmatic hernias.

5. Edge Shadowing

Description

Dark lines appearing at the edges of round or curved structures.

Cause

Refraction and scattering at curved surfaces.

Application

It is commonly observed in kidneys, gallbladder, urinary bladder, and can help confirm shape and border.

6. Comet Tail and Ring-Down Artifact

Description

Bright tapering lines extending from a source.

Cause

Reverberation in very small, closely spaced structures or air bubbles.

Application

It is seen in gas pockets, helps in diagnosing emphysematous conditions, intestinal gas, or abscesses with gas.

Surgical Patient Preparation and Hospital Asepsis

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Surgical Patient Preparation

Veterinary pre-surgical preparations involve a comprehensive approach to ensure patient safety and optimal surgical outcomes. This includes thorough patient assessment, appropriate fasting protocols, and administration of necessary pre-medications. Surgical aseptic techniques are crucial in preventing infections and complications, encompassing proper hygiene, sterile gowning and gloving, and maintaining a sterile surgical field throughout the procedure. Proper patient positioning and surgical site preparation are critical components of preoperative procedures, necessitating strict adherence to established protocols. This process commences with the careful positioning of the patient to ensure optimal access to the surgical site while maintaining their comfort and safety. Precise hair clipping in the surgical area is conducted to minimize contamination risk, followed by thorough cleaning and disinfection using approved antiseptic solutions. These steps are essential in reducing the risk of surgical site infections and promoting optimal healing.

The selection and use of appropriate surgical instruments and materials are vital for ensuring successful surgical outcomes. Surgeons must meticulously select instruments that are well-maintained, sterile, and suitable for the specific procedure being performed. Sutures are chosen based on their tensile strength, absorption properties, and tissue reactivity, considering the type of tissue being repaired and the expected healing time. In cases where implants are required, factors such as biocompatibility, durability, and potential for integration with the patient's tissues must be considered. The proper handling and placement of these materials during surgery significantly influence the overall success of the procedure.

Postoperative care and monitoring are equally important aspects of the surgical process, playing a crucial role in patient recovery and the prevention of complications. Pain management is a key component of postoperative care, involving the administration of appropriate analgesics and the implementation of non-pharmacological pain relief strategies. Wound care is another critical aspect, encompassing regular dressing changes, monitoring for signs of infection, and ensuring proper healing. Close observation of the patient's vital signs, fluid balance,

and overall condition is essential for the early detection of any potential complications. This vigilant monitoring allows for prompt intervention if issues such as infection, bleeding, or adverse reactions to medications arise. Furthermore, postoperative care extends beyond the immediate recovery period, often involving rehabilitation programs, dietary adjustments, and lifestyle modifications to support the patient's long-term recovery and optimize the surgical outcome.

Patient education is also a crucial component, ensuring that individuals understand their role in the recovery process and can recognize signs that may warrant medical attention. By implementing comprehensive pre-surgical preparations, utilizing appropriate surgical techniques and materials, and providing thorough postoperative care, healthcare professionals can significantly enhance patient outcomes and promote faster, more effective recovery.

The integration of advanced technologies in veterinary surgery has revolutionized the field, offering enhanced precision and improved patient outcomes. These technological advancements include minimally invasive surgical techniques, such as laparoscopy and endoscopy, which reduce surgical trauma and accelerate recovery times. Additionally, the use of imaging technologies like CT scans and MRI for surgical planning has greatly improved the accuracy of diagnoses and the effectiveness of surgical interventions. The integration of advanced imaging technologies, such as 3D modelling and virtual reality, has further enhanced the capabilities of RI in preoperative planning. Surgeons can now visualize complex anatomical structures and simulate procedures before entering the operating room, leading to more precise and personalized surgical approaches. This increased level of preparation not only reduces the risk of complications but also shortens recovery times for patients, ultimately improving overall healthcare outcomes.

Aseptic Techniques

Infection is one of the most potentially devastating and challenging complications of surgery, which may occur during surgery or at any time during hospitalization. All possible measures should be taken to reduce the risk of *iatrogenic infection*.

Asepsis is defined as the absence of microorganisms that cause disease, which should be applied to the entire hospital to control the pathogens and to protect both the patient and hospital staff (Aseptic techniques, medical asepsis, clean techniques).

Sterile is defined as being free of all living microorganisms. Sterile technique are more appropriate for the operating room (OR) setting, and applies to work performed in a sterile field. The higher level of protection in a sterile field is critical because the

natural defences of the patient are breached by surgical incision, puncture, or introduction of instruments into the vascular system. For example, arthrocentesis performed under sterile technique might require the use of sterile gloves, a sterile patient preparation kit, and a small drape, whereas the same procedure performed using clean or aseptic technique would require only nonsterile gloves and an alcohol wipe.

Transmission of Microorganisms may occur due to contaminated instruments and the environment, but the hospital staff is the most likely means of transmission. The specific means of transmission from staff to patient include airborne, droplet, and contact. Airborne and droplet types of transmission is less common in veterinary hospitals because of the low incidence of reverse zoonosis. Contact from another patient or from an environmental source, is the most common method. During surgery, contact from the patient's normal sources of bacteria such as the skin or nasopharynx may transmit infection to the surgical wound.

Sources of contamination may be divided into animal sources and inanimate sources. Animal sources include the skin and hair, the nasopharynx, and other orifices such as the vulva or anus. Inanimate sources include fomites and air. One cubic foot of air contains thousands of particles, which can increase to more than 1 million particles during a lengthy surgical procedure, because of traffic into and out of the room and other air currents that develop, and may cause 80% to 90% of microbial contamination of a surgical wound.

PRINCIPLES OF HOSPITAL ASEPSIS

Minimization of infection in a surgery practice involves applying principles of aseptic technique throughout the hospital. Goals are to minimize sources of contamination and to block transmission of microorganisms.

- Regular hand washing by hospital staff
- Use of nonsterile or sterile gloves when handling likely sources of pathogens, including high-risk patients (e.g., patients with known infection or wounds), equipment (e.g., contaminated sponges), and hospital surfaces
- Cleaning or disposal of equipment between patients
- Containment of contaminated supplies and equipment
- Proper storage of equipment
- Regular equipment cleaning protocols
- Proper handling of soiled laundry

- Scheduled cleaning of hospital surfaces
- Proper maintenance of hospital heating, ventilation, and air conditioning systems
- Minimizing unnecessary traffic
- Isolation of patients with known pathogenic microorganisms

Sterile Technique

All surgical procedures are ideally performed under sterile conditions to prevent the transmission of microorganisms into the body during surgery or other invasive procedures.

Surgical team members should remain within the sterile area, movement in the operating room (OR) by all personnel is kept to a minimum; only necessary personnel should enter the operating room as movement in the OR and outside of the sterile area may encourage turbulent airflow, resulting in cross-contamination.

- Talking is kept to a minimum as it releases moisture droplets laden with bacteria.
- Non-scrubbed personnel should not reach over sterile fields as dust, lint, or other vehicles of bacterial contamination may fall on the sterile field.
- Scrubbed team members should face each other and the sterile field at all times as the back is not considered sterile even if wearing a wraparound gown.
- Equipment used during surgery must be sterilized, and scrubbed personnel should handle only sterile items; non-scrubbed personnel handle only nonsterile items as non-scrubbed personnel and unsterile instruments may be a source of cross-contamination. If the sterility of an item is questioned, it is considered contaminated.
- Sterile tables are sterile only at table height. Items hanging over the table edge are considered nonsterile because they are out of the surgeon's vision. If the surgical team begins the surgery seated, they should remain seated until the surgery has been completed. The surgical field is sterile only from table height to the chest; movement from sitting to standing during surgery may promote cross-contamination.
- Sterile drapes are used to create a sterile field Drapes covering instrument tables or the patient should be moisture proof as moisture carries bacteria from a nonsterile surface to a sterile surface (strike-through contamination). Sterile items within a damaged or wet wrapper are considered contaminated.
- If a sterile object touches the sealing edge of the pouch that holds it during opening, it is considered contaminated. Once opened, sealed edges of pouches are not sterile.
- Hands may not be folded into the axillary region; rather, they are clasped in front

of the body above the waist. The axillary region of the gown is not considered sterile. Gowns are sterile from mid-chest to waist and from gloved hand to 2 inches above the elbow.

- All items introduced onto a sterile field should be opened, dispensed, and transferred by methods that maintain sterility and integrity; the sterile field should be maintained and monitored constantly.
- Surgical staff should be trained to recognize when they have broken technique and should know how to remedy the situation.

Effective Strategies for Managing Repeat Breeding in Dairy Cattle

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An animal's ability to reproduce is one of the key essentials in a dairy herd. Dairy farmers gain maximum profit if their herd provides one calf crop per year. A robust reproduction and production critically contribute to the profitability of the dairy enterprise. The perfect scenario for an individual dairy animal is to become pregnant within 90 days of calving, however this is usually not achieved. Most of the time cows suffer from repeat breeding while the buffaloes suffer from anoestrous. Repeat breeding is responsible for long service period and inert- calving interval thereby causing low milk and calf production resulting into greater economic loss to dairy industry. Repeat breeding has many predisposing factors, the predominant one are hormonal aberration and infections. Hormonal intervention can be used to improve oestrous detection and to increase pregnancy rates of dairy animals. Incidence of endometeritis in both cows and buffaloes is very high. Abnormal parturition, puperal complication, inseminations with unsterilized equipment and infected seen lead to uterine infection that develops into endometritis and eventually repeat breeding.

Repeat breeder cows are the bane of any dairy enterprise and one of the major causes of economic loss.

What is a repeat breeder cow?

- A cow that has regular oestrous cycle
- The cow does not possess or exhibit any palpable clinical abnormalities
- The dairy animal does not have any uncharacteristic vaginal discharge
- Is usually less than 10 years' age
- The cow has calved once and has failed to conceive despite at least three or more consecutive inseminations. These animals will regularly come to heat but not conceive despite matting / Artificial Insemination

Hormonal aberrations:

Various hormonal aberrations leading to poor conception rate and their interventions are described below.

Prolong duration of oestrous:

About 29-50% repeat breeding crossbred cattle display prolong oestrous period (37-60h vs 24-36h) that is associated with low conception rate (30% vs70%; Dadarwal *et al*.2005; Singh *et al*. 2009).

Treatment protocol for prolonged oestrus exhibiting repeat breeding cattle:

- Multiple inseminations or irrational hormonal interventions were able to conceive only partially equal to 19% of prolonged oestrus exhibiting cattle.
- Termination of luteal phase between days 7 to 9 post- Ovulation, normalized plasma progesterone and the duration of subsequent oestrus. The recorded pregnancy rate was 46% compared to nil in untreated cattle (Singh *et al*. 2006)
- Administration of GnRH (20µg Buserelin acetate) on the day of insemination leads to 34% pregnancy rate. An additional treatment with GnRH on day 12 post-insemination lead to 52% pregnancy rate in comparisons to 17% in untreated repeat breeder with prolonged oestrus
- Mid-luteal phase (Day 12 post-ovulation) GnRH treatment normalized post –treatment oestrus duration, improved luteal profile and conception rate (Honparkhe *et al*.2008).
- In fatty cattle, restricted feeding of concentrate, grain feeds and green fodder for two months reduced the length of oestrus period in 50% cattle. This treatment lead conception rate to 65% (Singh *et al*. 2009a)
- Treatment with controlled internal drug release (CIDR) for 7 days along with GnRH administration improved conception rate in prolonged oestrus exhibiting cattle.

Cystic ovarian disease (COD): These are defined as follicles with 2-2.5 cm diameter that are present on one or both ovaries and persist for at least 10 days in the absence of any active luteal tissue. Follicular cysts are uniformly an-echogenic with a thin wall, while luteal cyst have thicker wall (>3mm) that is visible as an echogenic rim. Higher incidence (30%) of COF is observed in crossbred cattle compared to indigenous cattle**.**

Cystic follicle can develop due to a dysfunction of the hypothalamic-pituitary-ovarian axis at either of the level, Viz. (a) GnRH or LH pulse frequency /amplitude is altered from the hypothalamus or pituitary, respectively. (b) pre-ovulatory LH surge is absent, insufficient or delayed and (d) altered feedback mechanism of estrogens on the hypothalamus -puitatry can result in an aberrant GnRH release. Suprabasal progesterone during estrus and stress due to higher milk yield are also considered to

be the predisposing factor of cyst formation. Treatment of COF with GnRH alone or in combination with PGF2alpha was successful to induce conception in 35-55% crossbred cattle (Singh *et al* 2008).

Antiluteolytic measures to reduce early embryonic mortality

One of the major factors influencing reproductive efficiency of dairy animals is embryonic mortality, which is referred to losses occurring before day 45 of gestation. Early embryonic mortality (EEM: animals return to estrus within 25 days after fertilization) could range from 20-44 percent and late embryonic mortality (Losses occur between days 25-45 of gestation) could range from 8-17 %. EEM has been attributed as a predominant cause for repeat breeding in dairy animals, through a list of factors including genetic predisposition, nutrition, age, climate insemination time, semen quality, infectious agents and endocrine imbalance particularly of progesterone and estrogen. Luteal deficiency is one of the predisposing factors causing EEM. The methods to supress luteolytic mechanism during post - insemination critical period (d 15-17) through various approaches is a possible strategy for improving conception rate in dairy animals. The remedial measures are given below.

- GnRH administration on the day of oestrus: Administration of GnRH/hCG just prior to or at the time of AI, causes ovulation. In addition, these injections increase the development of CL and hence peripheral progesterone and increased pregnancy rate in repeat breeding cows
- GnRH/hCG administration on day 5 of oestrous cycle: Administration of GnRH/hCG on days 5 or 6 after oestrous altered follicular dynamics, induced luteal tissue development, and increased plasma progesterone resulting in 45% increase in pregnancy rate
- GnRH/hCG administration between days 11-15 of oestrous cycle: following day 12 treatment with hCG/GnRH, an accessory ovulation was reported and causes prolongation of life span of CL and had 10-12% higher pregnancy rate

Infectious causes of repeat breeding

Endo metritis is often self-limiting with recovery occurring after subsequent oestrous cycles. If UDM (Uterine defence Mechanism) is impaired or weakened, bacteria may colonise the uterus and lead to development of uterine infection and endometritis. The component of UDM include phagocytosis, Immunoglobulin, mucus, secretion and normality of epithelium. There are several factors which affect UDM viz. number of neutrophil in the uterine fluid and their ability to phagocytose

bacteria, species and quantity of bacteria, type and other bacterial enzyme in the uterine lumen. Thus an effective treatment is one which increases the uterine defences and excludes bacterial infections. So Paisley *et al.* 1986 recommended that the ideal therapy for uterine infections should eliminate the bacteria from uterus, but should not inhibit the normal UDM and should not cause further adulteration of milk or meat for human consumption.

Current therapies

In general, the current therapies of endometritis and uterine infection can be classified into six major types.

1. Antibiotic: these have been widely used as treatment of uterine infections. Success of these treatments varies from beneficial to no benefit to recommendation against their use. When using penicillin, it inactivated through bacterial production of the enzyme penicillinase. In case of tetracycline, the need of large systemic dose to get tissue concentration against *A. pyogenes* could be toxic to the animal. The anaerobic environment of uterus makes aminoglycoside group of antibiotics (gentamicin, kanamycin, streptomycin and neomycin) ineffective because they require oxygen for their activity. These antibiotics also inhibit phagocytosis. This suppression of leukocyte activity is further increased if the bacteria were resistant to the applied antibiotic. In endometritis, the absorption of many drugs is diminished, due to which therapeutic level in the deeper layers of the uterus and other part of genital tract are not likely to be achieved. The poor response to intrauterine treatment is likely due to:

- Drugs used for retention of foetal membrane (ROFM) do not accelerate the loosening process in the placentomes and in fact, may delay it.
- Intrauterine manipulation (manual removal, antibacterial infusion etc.) are traumatizing and inhibit the phagocytosis that is necessary for placental detachment and clearance of infection.
- Intrauterine infusion of sulphonamides as a therapy has also been reported. Appreciable concentrations of sulpha drug can be detected in milk even 24 hrs after administration. Bacterial activity of sulphonamides, aminoglycosides and nitofurazone is greatly reduced in an environment containing blood, pus, necrotic tissues, products of leukocytes and tissue damage.

2. Antiseptics: Weak or dilute lugol's iodine solution has been reported to be an effective treatment of endometris. It has been recommended that routinely used

antiseptics adversely affect the uterine natural defence mechanism against infection.

3. Hormonal Therapy:

(a) Oestrogen: It improves the UDM of reproductive tract by increasing the blood circulation, leukocytic infiltration to the uterus, uterine contractions and mucus flow and phagocytosis. Small dosage (5 or 6 mg) of oestradiol benzoate i/m during early post-partum period (after 6 Days) are reliable treatment of cows with or without retention of foetal membranes. However, long-acting oestrogen and stillbestrol have been associated with more severe infections of oviducts and myometrium, development of cystic ovaries and depressed fertility from unknown causes (Paisley et al., 1986).

(b) Oxytocin: Oxytocin also increase phagocytosis. This effect can be seen up to 8 days' post-partum if involution has been delayed.

(c) Prostaglandin F_2 alpha: PGF_2 alpha and its analogues have been used as treatment of endometritis in cows. Paisley *et al*. (1986) recommended that the rationale of using PG for Post-Partum uterine infection include: Luteolysis and decreased progesterone inhibition of UDM, increased oestrogen induced UDM, increased myometrium contractions and expulsion of lochia and other contents from the uterus, and stimulated phagocytosis by uterine leukocytes. It was concluded that repeated administration of PGF_2 alpha on day 10 of cycle for six successive cycles resulted in a normal response of oestrus without development of cystic ovaries, which made if superior to estrogenic as a treatment of endometritis. Advantages of systemic use of antibiotic include easier administration, less risk of introducing new infection and causing injury to endometrium, depressing phagocytic activity and no loss antibiotics with uterine contraction. However, large dose of drug is required to achieve the optimum level of drug in the uterine lumen.

(d) Ovsynch Protocol: A protocol involving GnRH, prostaglandin F2α, and GnRH again, followed by TAI, has been shown to increase conception rates in repeat breeders.

4. Nutritional Management: Proper nutrition, including mineral supplementation and avoidance of overfeeding or mouldy feed, is essential for reproductive health.

5. Improving Oestrus Detection: Accurate and timely detection of estrus (heat) is

crucial for successful insemination.

6. Immunomodulatory: It is obvious from most of the reports that parenteral and intrauterine treatment with various antibacterial drugs gave inconsistent results. High cost of treatment, compulsory milk disposal, development of resistance to antibiotic, inhibition of UDF all led to find an alternative therapy for the treatment of uterine infection. So the people are trying to use substances which cause activation of UDM. These substances are

***E. Coli* Lipopolysaccharide (*E. Coli* Endotoxins, *E. Coli* LPS):** *E. coli* LPS and bacteria free filtrate of streptococci infusin to uterus effectively increased the influx of PMN into uterus by chemotaxis. Chemotaxis of PMN's to uterine lumen has been reported to play an important role in the pathogenesis and resolution of endometritis.

Serum, Plasma and Hyper immune serum: 50-100 ml of autologous plasma for 3 days can be given in the uterus. Intrauterine infusion of immunomodulatory have several disadvantage like:

- Loss of one oestrous cycle
- Inadvertent administration of infectious organism in the uterus.
- Failure to respond in severe cases of endometritis and pyometra

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Suture and Suturing Techniques in Veterinary Practice

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Definition of Suturing

Suturing is the process of **approximating tissues using sterile thread-like materials (sutures)** to facilitate healing and restore anatomical continuity after injury or surgery.

2. Objectives of Suturing

- Achieve **hemostasis**
- Promote **primary wound healing**
- Minimize **infection and inflammation**
- Maintain **tissue strength and function**
- Provide **aesthetic closure** where necessary

Factors Affecting Suturing

Characteristic	Description
Biocompatibility	Non-toxic, non-carcinogenic, minimal tissue reaction
Tensile Strength	Adequate strength to hold tissues until healing occurs
Knot Security	Holds knots firmly without slipping or untying
Handling Properties	Easy to pass through tissue, flexible, minimal memory
Minimal Tissue Reaction	Should not provoke inflammation or hypersensitivity
Predictable Absorption	For absorbable sutures –known rate of degradation aligned with healing
Sterilizable	Must be capable of sterilization without degradation
Economical & Available	Cost-effective and easily accessible in field or clinic

Characteristics of an Ideal Suture Material

An ideal suture should:

Factor	Influence on Suturing Outcome
Wound Type & Location	Determines suture technique and material; e.g., facial wounds require finer sutures
Tension on Wound Edges	Excess tension causes dehiscence or necrosis; must select tension-bearing suture patterns
Tissue Type	Fragile tissues (e.g., liver, bladder) need atraumatic needles and fine sutures
Patient Factors	Age, nutrition, systemic diseases (e.g., diabetes) affect healing capacity
Suture Technique Used	Interrupted vs. continuous; everting vs. inverting affects tissue apposition
Sterility & Aseptic Conditions	Poor asepsis can lead to infection, dehiscence
Skill of the Surgeon	Proper needle angle, depth, and knot technique are crucial for success

TYPES OF SUTURE MATERIAL

Classification of Suture Materials

A. Based on Absorbability

Type	Characteristics	Examples
Absorbable	Broken down and absorbed by the body over time via enzymatic or hydrolytic action	Catgut, Vicryl, Dexon, PDS
Non-Absorbable	Permanently retained unless removed; used where long-term support is needed	Silk, Nylon, Prolene, Stainless steel

B. Absorbability:

Type	Characteristics	Examples
Monofilament	Single strand; less tissue drag; resists infection	Nylon, Prolene, PDS
	Multiple fibers twisted or braided; better handling, more tissue reaction	Silk, Vicryl, Dexon

C. Based on Origin

2. Absorbable Suture Materials

A. Catgut (Plain & Chromic)

- **Origin**: Natural (sheep intestine)
- **Absorption**: Enzymatic (complete in 7–10 days for plain; 21–28 days for chromic)
- **Uses**: Ligation, subcutaneous closure
- **Disadvantage**: High tissue reaction, unpredictable strength loss

B. Polyglactin 910 (Vicryl)

- **Type**: Synthetic, braided
- **Absorption**: By hydrolysis, complete in 56–70 days
- **Advantages**: Predictable strength loss, minimal tissue reaction
- **Uses**: General soft tissue approximation, including muscle and subcutis

C. Polyglycolic Acid (Dexon)

- **Type**: Synthetic, braided
- **Absorption**: Hydrolytic, ~90 days
- **Uses**: Similar to Vicryl; useful in intestinal and bladder surgeries

D. Polydioxanone (PDS)

- **Type**: Synthetic, monofilament
- **Absorption**: 180+ days (slow)
- **Uses**: Fascia, tendons, long-term support tissues
- **Advantages**: Strong, low tissue reaction

3. Non-Absorbable Suture Materials

A. Silk

- **Type**: Natural, braided
- **Tissue Reaction**: High
- **Use**: Cardiovascular, ophthalmic, ligatures
- **Disadvantage**: Can act as a nidus for infection

B. Nylon (Ethilon, Dermalon)

- **Type**: Synthetic, monofilament
- **Properties**: High tensile strength, minimal reaction
- **Uses**: Skin closure, orthopedic repairs

C. Polypropylene (Prolene)

- **Type**: Synthetic, monofilament
- **Properties**: Inert, excellent tensile strength
- **Uses**: Cardiovascular, skin, plastic surgeries

D. Polyester (Dacron, Mersilene)

- **Type**: Synthetic, braided or coated
- **Use**: Tendon repair, orthopedic surgeries
- **Caution**: May saw through tissue

E. Stainless Steel

- **Type**: Monofilament or twisted
- **Use**: Orthopedic surgery, sternum closure, herniorrhaphy
- **Advantages**: Maximum strength, inert
- **Drawbacks**: Poor handling, kinks easily

4. Suture Size System

USP Size Diameter (approx.)	Common Use
0 – 2 Large size	Tendons, ligaments, large vessels
2-0 to 4-0 Medium	Skin, fascia, subcutis
5-0 to 7-0 Fine	Ophthalmic, microvascular

5. Suture Material Selection: Tissue-Based Guide

Tissue Type	Recommended Suture
Skin	Nylon, Prolene (non-absorbable)
Subcutis	Vicryl, Dexon (absorbable)
Muscle	Vicryl, PDS
Bladder/Intestine	Vicryl, PDS (rapidly absorbable)
Fascia	PDS, Prolene (high tensile, delayed absorbable)
Tendon	Prolene, Polyester, Stainless steel

DIFFERENT TYPES OF SURGICAL KNOTS

1. Definition of Surgical Knot

A **surgical knot** is a method of securing suture material during or after wound closure to maintain **tissue approximation**, hemostasis, and stability.

2. Essential Qualities of a Good Surgical Knot

- Secure and firm
- Minimal tissue trauma
- Easy to tie and adjust
- Resistant to slippage
- Does not loosen with tension

3. Common Types of Surgical Knots

Knot Type	Description	Application
Simple Knot	A single half-hitch; insecure if used alone	Starting point; must be followed by more throws
Square Knot	Two opposite half-hitches (right over left, then left over right)	Most commonly used in surgery
Surgeon's Knot	First throw is a double half-hitch, second is a single (e.g., double overhand)	Provides more friction; used under tension
Granny Knot	Two identical half-hitches (e.g., right over right)	Tends to slip; not recommended for final knots
Sliding Knot	Knot can be tightened by pulling ends	Used in laparoscopy, deep tissue where tight space
Ligature Knot	Secure ligation of blood vessels or pedicles; square or surgeon's variant	Hemostasis in vascular or organ ligation
Miller's Knot	Friction knot with a locking loop; secure on large pedicles	Common in large animal ovariectomy
Aberdeen Knot	Self-locking finishing knot for continuous sutures	Quick closure of continuous sutures

4. General Rules for Knot Security

- Use **at least 3 throws** for monofilament and **4–5 for multifilament** sutures.
- Avoid excessive tension that may cause **tissue necrosis** or **suture breakage**.

- Ensure **flat, even knot placement** to minimize irritation and slippage.
- Wetting synthetic sutures improves **knot tying** and **grip**.

SUTURE PATTERNS

1. Classification of Suture Patterns

A. Based on Tissue Effect

Type	Effect on Tissue Edges	Purpose
Appositional	Brings tissue edges edge-to-edge	Ideal for skin, fascia, intestine
Everting	Rolls tissue edges outward	Used in skin or tension-bearing areas
Inverting	Rolls tissue edges inward	Used in hollow organs to reduce leakage
Special	Combines functions or used in specific situations	Deep layers, cosmetic closure

2. Appositional Suture Patterns

Pattern	Type	Use
Simple Interrupted	Interrupted	Skin, muscle, fascia
Simple Continuous	Continuous	Skin, subcutaneous, intestines
Cruciate	Interrupted	Skin closure in large animals
Ford Interlocking	Continuous	Skin in large animals, better strength
Subcuticular/Intracutaneous	Continuous	Cosmetic skin closure

3. Everting Suture Patterns

Pattern	Type	Use
Vertical Mattress	Interrupted	Skin under tension; strong eversion
Horizontal Mattress	Interrupted	Skin, especially in areas of high tension
Near-Far-Far-Near	Interrupted	Deep wounds, high tension

4. Inverting Suture Patterns

Pattern	Type	Use
Lembert	Interrupted/Cont.	Intestinal and hollow viscera closure
Cushing	Continuous	Serosa and submucosa of hollow organs
Connell	Continuous	Full-thickness hollow organ closure (caution)
Halsted	Interrupted	Intestinal, layered closure
Parker Kerr	Continuous	Used to invert stump of hollow organs

5. Special Suture Patterns

Tissue Type	Recommended Suture
Skin	Nylon, Prolene (non-absorbable)
Subcutis	Vicryl, Dexon (absorbable)
Muscle	Vicryl, PDS
Bladder/Intestine	Vicryl, PDS (rapidly absorbable)
Fascia	PDS, Prolene (high tensile, delayed absorbable)
Tendon	Prolene, Polyester, Stainless steel

6. General Tips for Pattern Selection

- Use **appositional patterns** for skin, muscle, and fascia.
- Use **inverting patterns** for **viscera (intestine, bladder, uterus)** to minimize leakage.
- **Everting patterns** are best where **tension** is present and in **skin closures**.
- **Interrupted sutures** allow precise tension control and security.
- **Continuous sutures** are faster and provide better sealing but less secure if one part fails.

Clinical Tip: Always match suture pattern with **tissue type, healing capacity**, and **functional need** of the surgical site.

Examine the Reproductive Health using Ultrasonography

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1. Introduction

Dairy production sectors depend significantly on efficient bovine reproductive health. While traditional per-rectal palpation remains widely practiced, it provides limited dynamic insight. In contrast, ultrasonography delivers immediate, dynamic images of ovarian and uterine anatomy, enabling earlier, safer, and more accurate diagnosis than possible with palpation alone. Introduced in the late 20th century, reproductive ultrasonography quickly became indispensable in bovine medicine, from tracking follicular waves and luteal development to early pregnancy assessments, fetal sexing, and diagnosing ovarian pathologies. Moreover, it plays an essential role in postpartum uterine involution, cystic ovarian disease management, and guiding invasive procedures like follicular aspiration. Adopting ultrasonography in dairy herds enhances reproductive outcomes, reduces calving intervals, and improves herd fertility in modern livestock systems. When combined with therapeutic or assisted reproductive technologies, its clinical impact deepens further.

2. Principles of Ultrasonography

Ultrasonography utilizes high-frequency sound waves (2–15 MHz) generated by piezoelectric crystals. These sound waves are emitted by a transducer and reflected back from tissue interfaces, producing real-time two-dimensional (B-mode) images. The nature of the echo depends on tissue density, fluid content, and structural homogeneity. The principle components include:

- **Acoustic Impedance**: Determines the reflection of ultrasound waves at tissue boundaries.
- **Attenuation**: Reduction of wave intensity with tissue depth; important for probe selection.
- **Resolution**: Higher frequency = better resolution, lower penetration; lower frequency = deeper penetration.

Transducers used in bovine reproductive work are typically linear or convex rectal probes with a frequency of 5–7.5 MHz.

3. Equipment and Setup

3.1 Ultrasound Machine:

- Portable real-time B-mode scanner
- Rectal linear/convex probe
- Power source or battery-operated unit

3.2 Accessories:

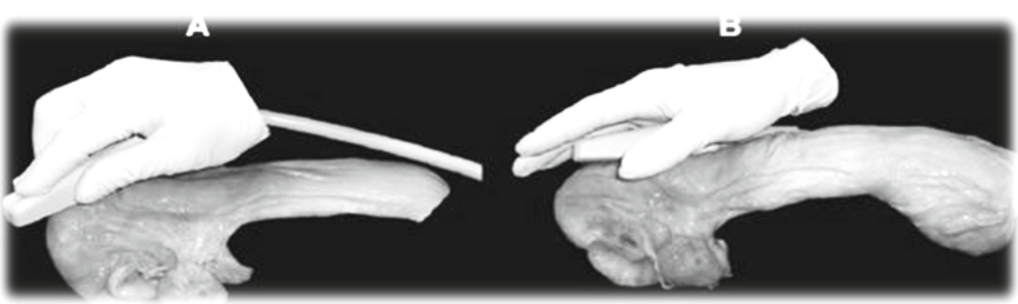
- Shoulder-length gloves
- Lubricants
- Ultrasound gel
- Protective sheath for probe

3.3 Pre-scan Preparation:

- Restrain animal in travis
- Tie tail and evacuate rectum
- Lubricate probe and hand
- Calibrate depth and gain on ultrasound unit

4. Ultrasonographic Technique in Bovine Reproduction

4.1 Transrectal Scanning Procedure



- Introduce gloved and lubricated arm per rectum
- Locate urinary bladder, cervix, uterus, and ovaries by palpation
- Gently place the probe dorsally against the target organ
- Adjust machine settings for optimal visualization

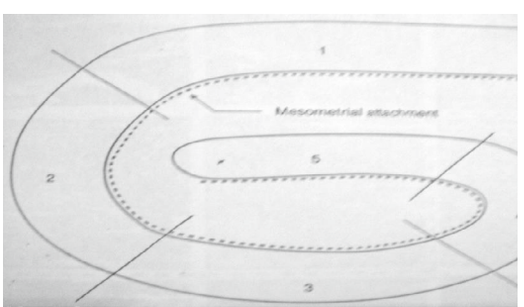
4.2 Identification of Reproductive Structures

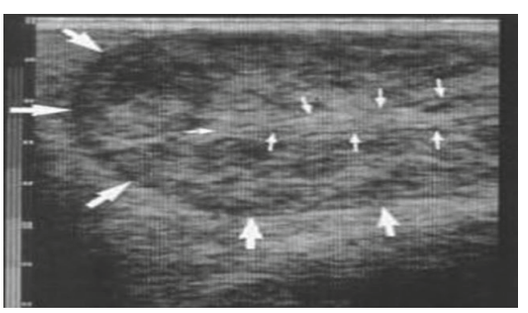
Urinary Bladder:

- Although not the part of reproductive organ
- Due to its easy visibility act as landmark during sonography of reproductive organs

Uterus:

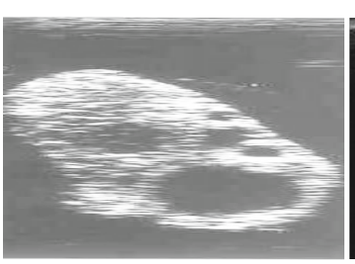
- Non-pregnant: tubular, uniform echogenic wall
- Pregnant: fluid-filled horn with hypoechoic content



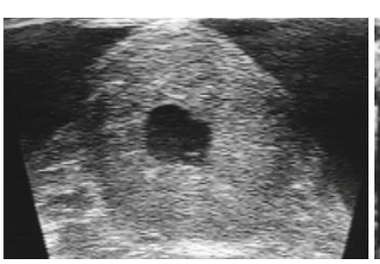


Ovaries:

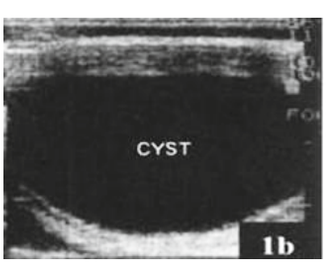
- Follicles: Anechoic (black), round, 3–20 mm
- CL: Mixed echogenicity; central cavity in early luteal phase
- Cysts: Thin-walled, large (>25 mm), anechoic or hypoechoic



Follicles- Black

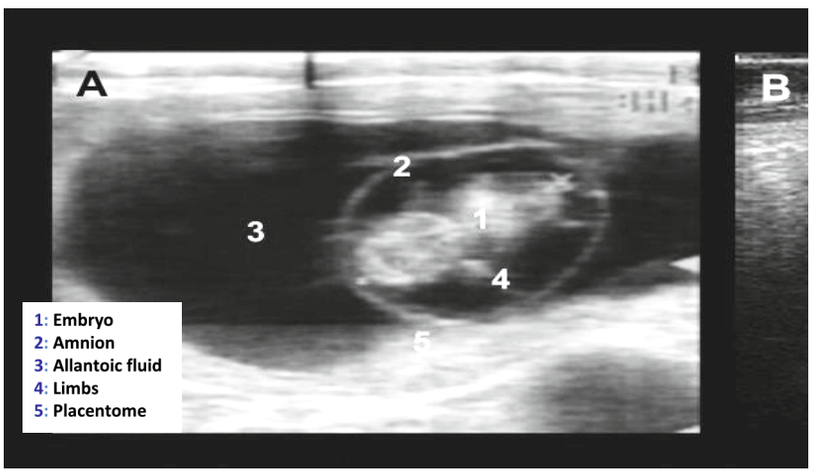


Mature CL with Central cavity



Follicular Cyst

Pregnancy Diagnosis:

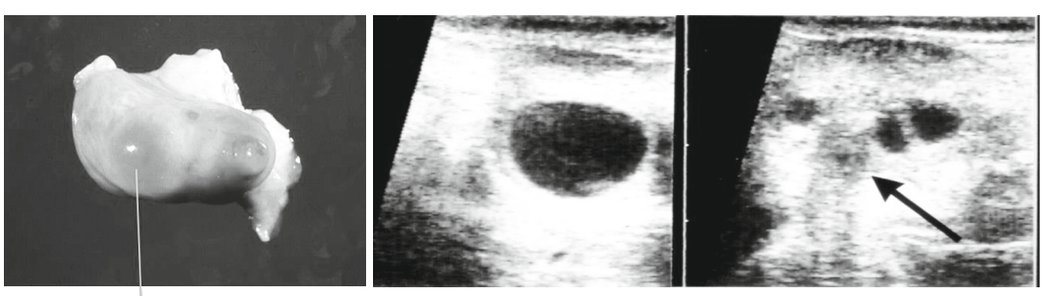


- Day 25: Anechoic embryonic vesicle
- Day 30–35: Embryo with heartbeat
- Day 45–60: Limb buds and placentomes visible

5. Main Field Applications of USG in Large Animal Reproductive Management

5.1 Estrus Detection and Synchronization Monitoring

- Follicular growth can be monitored, size of about 15-16 mm in absence of CL indicate the preovulatory follicle. Uterine tone and turgidity indicated by presence of vascularity are also seen during estrus.
- Confirmation of ovulation – absence of preovulatory follicle in second consecutive sonography at 12-24 h interval.

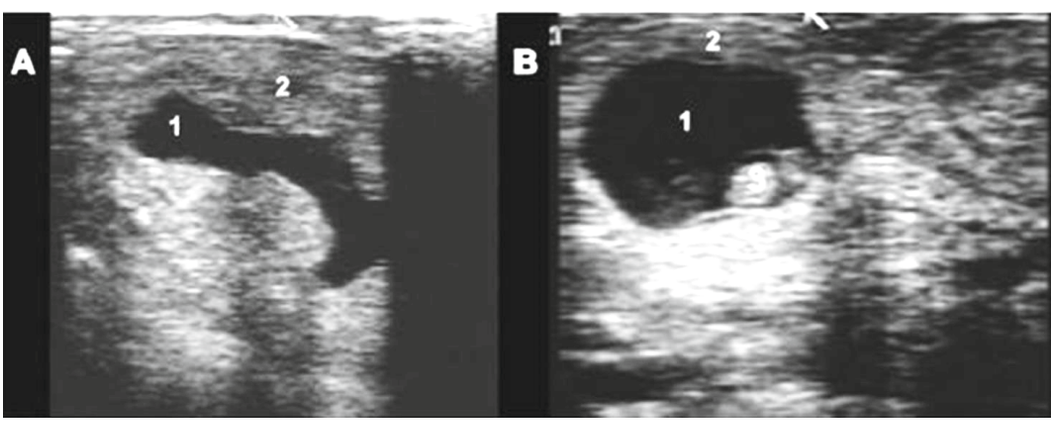


Pre-ovulatory follicle | Pre-ovulatory follicle | 12 hours later, Ovulation has occurred

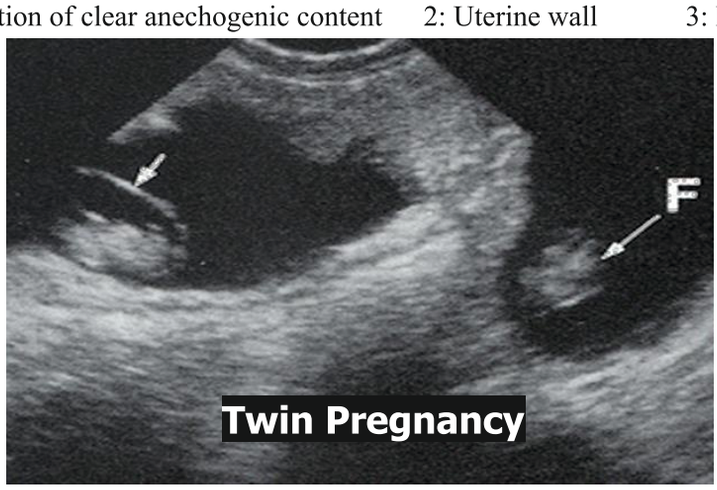
5.2 Early Pregnancy Diagnosis

- Accurate from Day 25–28 post-AI
- Heartbeat, limb movement, crown-rump length measurement
- Differentiation from pseudopregnancy, mucometra
- Detecting twins

Differential diagnosis of mucometra (A) & early pregnancy (B)
(7.5 MHz; depth 5 cm)

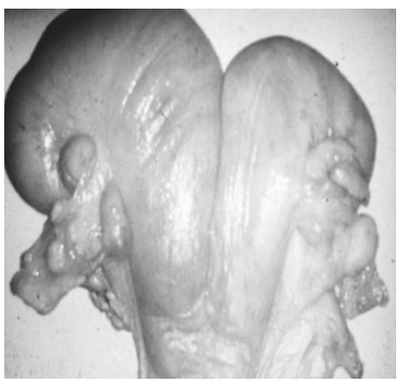


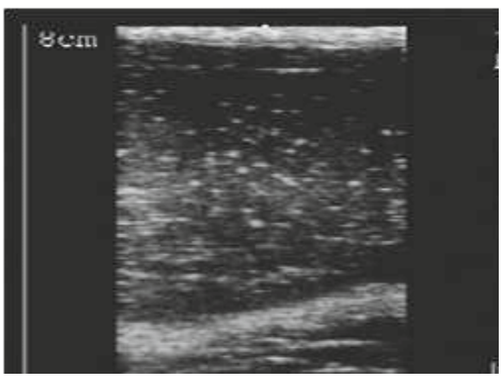
1: Accumulation of clear anechogenic content 2: Uterine wall 3: Embryo



5.3 Diagnosis of Reproductive Pathologies

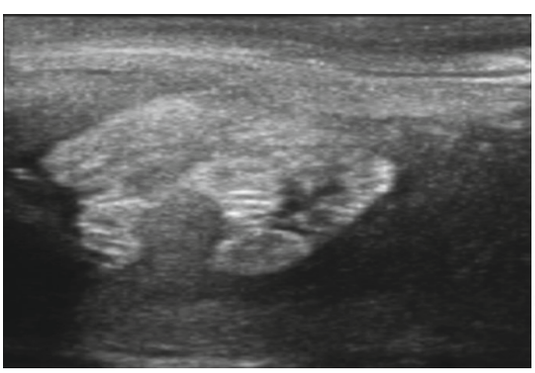
- Pyometra: Echogenic fluid with debris in uterine lumen
- Mucometra/Hydrometra: Anechoic fluid without debris





Pyometra

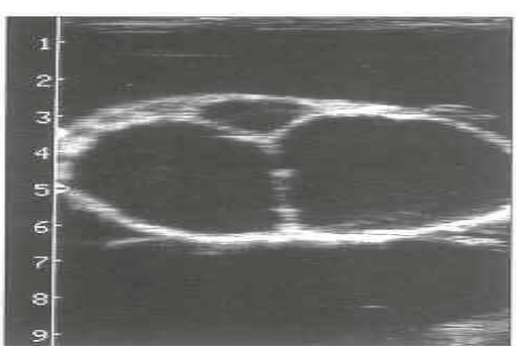
- Mummified fetus
- Fetal ascites



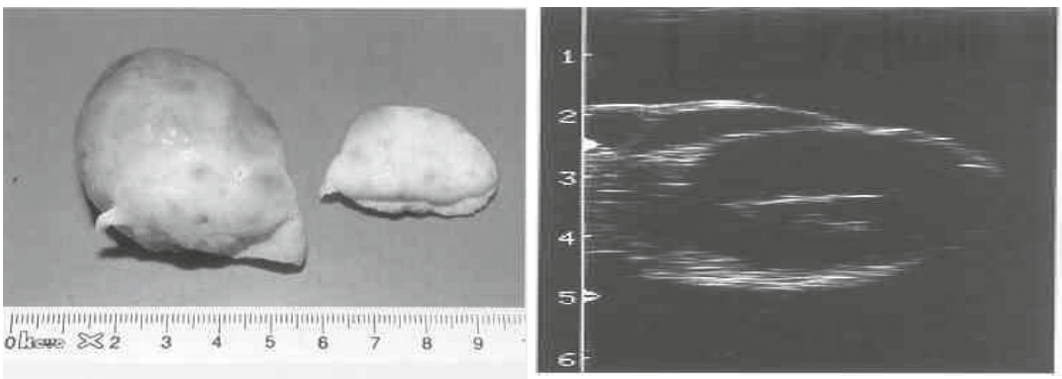
Mummified fetus

Ascitic fetus

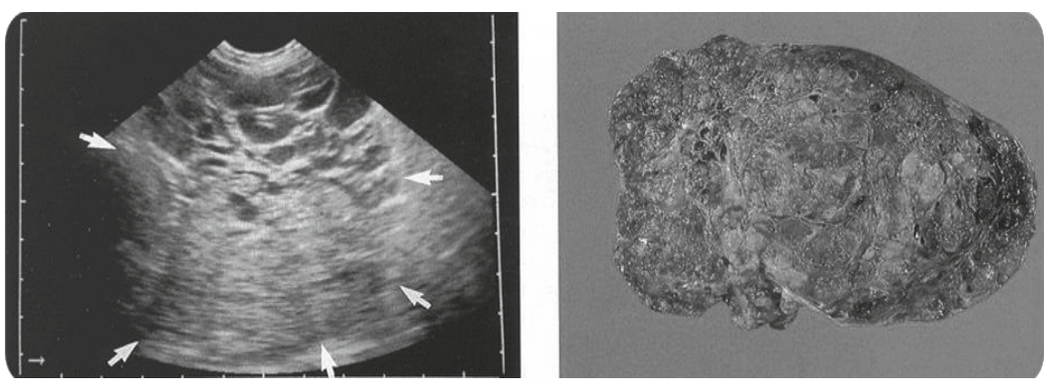
- Ovarian cysts: Persistent large follicles or luteal cysts
- Ovarian tumour



Follicular Cyst



Luteal Cyst



Ovarian Tumour

Advantages of Ultrasonography in Reproductive Practice

- Non-invasive and animal-friendly
- Early and accurate diagnosis
- Real-time functional assessment
- Improves reproductive efficiency and reduces calving interval

Limitations and Constraints

- High initial cost of equipment
- Operator-dependent interpretation
- Requires skilled personnel and training
- Limited field utility in extreme weather or remote areas

Recent Advances

- **Color Doppler Ultrasonography**: Assesses blood flow to CL, uterus, and fetus
- **3D Ultrasound**: Advanced structural evaluation
- **Automated follicular tracking**: AI-based interpretation

Recommendations for Clinical Practice and Training

- Incorporate ultrasonography into standard reproductive examination protocol
- Participate in hands-on training on USG
- Integrate with herd health and fertility monitoring programs

Conclusion

Ultrasonography has transformed reproductive diagnostics in bovines by delivering enhanced precision, safety, and procedural efficiency. Its versatility spans estrus detection, early pregnancy confirmation, and identification of genital or fetal abnormalities. These applications are now integral to routine herd reproductive programs. Research shows that B-mode imaging enables detection of viable embryos by 28–30 days post-insemination, with earlier functional assessment now possible through color Doppler evaluation of corpus luteum vascularization. With adequate training and investment in mobile ultrasound technology, practitioners can apply ultrasonography effectively in field settings, significantly enhancing fertility management in dairy herds. Looking ahead, innovations—including Doppler imaging to assess luteal and uterine blood flow**,** AI-powered image analysis for automated diagnostics, and compact, robust portable devices are expanding accessibility and accuracy, ushering in a new era of precision veterinary reproductive care.

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Diagnostic Approaches to Veterinary Parasitic Infections

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Parasitic infections cause severe morbidity and mortality in animals and thus affect the economy of livestock owners by decreasing the ability of the farmer to produce economically useful animal products. Parasitic infections adversely affect animal's health and threaten profitable animal production, thus affecting the economy of our country.

Parasites infection/infestation	**Economic losses due to parasitic infection or gain after parasitic treatment**	**References**
Helminthic infection	Increased 12 litre milk in 100 days after anthelmintic treatment	Sanyal *et al.* (1992)
Paramphistomosis	1.60 litre/day in cow and 1.31 litre in buffaloes after anthelmintic treatment	Kumar *et al.* (2007)
Helminthic infection	Increased milk production 04 -18 percent in cow after anthelmintic treatment	Das *et al.(*2017)
Tick and Tick - bornediseases (TTBDs)	13.9- 18.7 billion US $ losses in production annually in the world	De Castro (1997)
Tropical bovine theileriosis	800 million US $ losses in India	Devendra (1995)

Economic losses of farmers (due to decreased milk production, draught power capability and reproduction performance) can be minimized by controlling parasitic infections in animals.Appropriate control measures against parasitic infections is mainly dependedupon the detection of parasites.Diagnosis of parasites generally done on the basis of symptoms or detection of parasites or its stages from the materials collected from the herds and the flock by necropsy.

Samples to be required for the diagnosis of various parasites:

- **Faeces**
- **Blood**
- **Nasal scraping**

- **Urine**
- **Lymph node biopsy**
- **Skin scraping**
- **Sputum**

A. Faecal Examination:
Gastrointestinal parasites:

Helminths			**Protozoa**
Nematodes (round worms)	**Cestodes (Tapeworms)**	**Trematodes (Flukes)**	
Ancylostoma spp. (Hook worm), *Haemonchus contortus* (Barber pole worm), *Toxocara vitulorum* (Ascaris of calf), *Strongylus* etc.	*Moniezia expansa, Moniezia benedeni, Taenia solium, Dipylidium caninum, Echinococcus granulosum* etc.	*Fasciola* spp. (liver fluke), Amphistomes, Schistosomes (blood flukes) etc.	*Entamoeba histolytica*, *Giardia* spp., *Balantidium coli*, *Eimeria* spp. (Coccidia), *Cryptosporidium* spp., *Toxoplasma gondii*etc.

Faecal Examination Methods:
To diagnose or detect the gastro intestinal parasites or it's eggs and other stages.

Materials/Equipment to be required for the diagnosis of Gastro-intestinal Parasites:-

- Specimen collecting vial
- Faeces
- Glass slide
- Tooth pick
- Cover slip
- Microscope
- Formalin (10 %)
- Ethyl alcohol
- Lugol's Iodine
- Camel hair brush

Collection of faeces

Faecal samples should be collected from the rectum of the suspected animals because such samples give a more reliable picture of the infection. In large animals collection of faeces from the rectum can be done by hand without difficulty. Smaller animals such as lamb and dogs can be induced to defecate by inserting a moistened little finger into the rectum and gently massaging with a rotatory motion and then sample may be collected. For collection of samples use stoppered wide mouth bottles 20-30 ml capacity (for dispatching) or petridishes (for early examination). A sufficient amount of faces should be collected, specially of the herbivores, as their faces contain considerable amount of roughage. Care should be taken during the collection of faecal samples that they should not be intermixed with the animal's faeces.

Preservation of collected faecal samples

Since eggs embryonate rapidly, the faeces should be stored in the refrigerator unless examination is carried out within a day. Some timesfaecal samples sent to laboratory examination for long Distances through the post, the addition of twice the volume of 10 % formal into the faeces will minimize development and hatching.

Examination of Faces

(A) Gross examination of Faces

Faces are examined in the first place for adult parasites, larval stages of insects(e.g. bots) and segments of tape worms.

(B) Microscopic examination

(a) Direct smear method

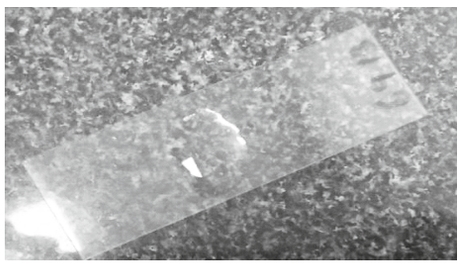
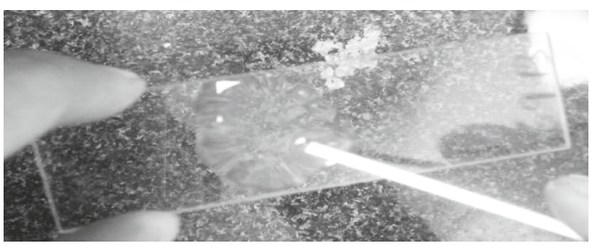
A small quantity of fresh faces is placed on a slide, mixed with a small droplets of water or normal saline with the help of needle evenly spread over the slide and coverslip is placed on the fluid and examined under low power microscope.

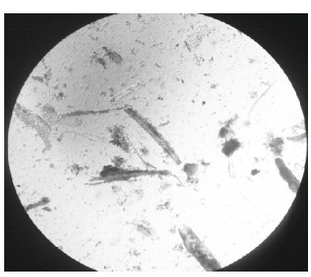
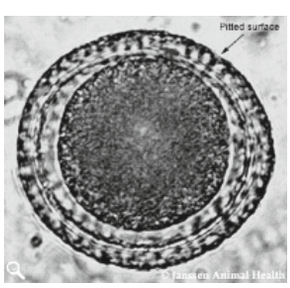
Advantages

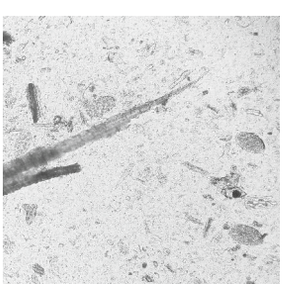
1. This is a simple technique and can be performed at field condition without any equipment.
2. This is a quick test, so that large number of samples can be performed in a very short time.
3. This test is useful in the diagnosis of (i) heavy coccidian and helminthic infections and (ii) cestode and trematode eggs (mainly in birds).

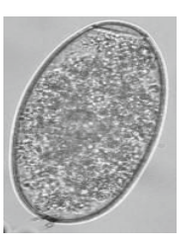
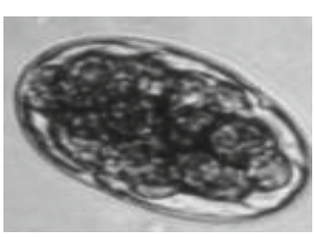
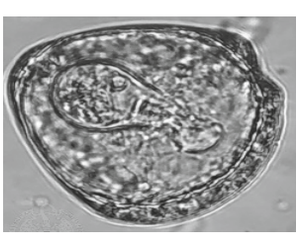
Disadvantage

1. This method is qualitative so severity of the infection can not be determined.
2. It is usually fails to detect low grade infection and is only suitable when the Concentration of parasitic stage is high.



Egg of *Fasciola* Egg of *Amphistome* Egg of *Moniezia expansa*

Floatation Method:-

Requirements

- Fresh or 10 % formalin or 70 % ethyl alcohol preserved faecal sample
- Microcsope
- Glass slide
- Cover slip
- Tooth pick
- Flat bottam test tube
- Dropper
- Saturated salt solution
- Water

Principle:

When parasitic eggs or protozoan cysts are suspended in a liquid with a specific gravity higher than that of the eggs, the eggs will float up to the surface. Nematode and cestode eggs float in a liquid with a specific gravity of between 1: 10 and 1:20. Trematode, which are much heavier, require a specific gravity of 1.30 – 1.35.

Common saturated solution used in floatation technique;-

- Sodium Chloride (Specific gravity- 1.20)
- Sugar- Sucrose (Sp. Gr. – 1.12 – 1.30)
- Zinc sulphate- 30 % (Sp. Gr. – 1.18)
- Magnesium sulphate – 35 % (Sp. Gr. – 1.28)
- Sodium nitrate (Sp. Gr. – 1.36)

Procedure

- About 2.0 g of faces are mixed with 10 – 20 ml of saturated common salt solution (brine) in a small floatation tube.
- Fill the floatation tube upto the tip with solution.
- A clean coverslip or slide is slid sideways over the top of the tube.
- Left about 30 minutes by which time all the eggs would have floated up and touches the coverslip.
- Then coverslip or slide is gently lifted, inverted and examined the fluid film under low power of the microscope.
- This method is not suitable for eggs of trematodes or most cestodes but is useful for the majority of nematode eggs.

Zinc sulphate centrifugal technique

Procedure: -

- Faecal suspension is prepared by mixing one part of a faecal sample and 10 parts of

luke warm water.

- About 10 cc. Of the suspension is strained through one layer of wet cheese cloth and filtrate are centrifuge for 2 or 3 times until the supernatant is clear.
- Then sediment is mixed with a saturated solution of Zinc sulphate in a centrifuge tube and then centrifuge for 1 or 2 minutes.
- Eggs will float to surface and then touch the coverslip with the surface of solution.
- Lift the coverslip gently and placed it on a clean slide and examined under a microscope.

This method is suitable for the detection of eggs of cestodes, most of the nematode and oocyst of coccidian.

A. Blood Smear Examination:

For the diagnosis of haemoprotozoan parasites (*Trypanosma*, *Theileria*, *Babesia*, *Hepatozoon* etc.), microfilaria of *Dirofilarial immitis* (heart worm of dog), rickettsial organisms (*Anaplasma*, *Ehrlichia* etc.)

Preparation of blood smear

Requirements:

- Glass slide
- 2% glacial acetic acid in ethyl alcohol
- Distilled water
- Anticoagulants
- Spirit
- Needle

Procedure

Cleaning of slides:

The slides should be hard, non-fogging white glass with no sharp edges. For faecal examination, 25 x 75 mm (regular size) size is used. When making a preparation on a slide, it is most important that the slides should be absolutely grease free and clean. To make it absolutely grease-free the slides are soaked overnight in 2% glacial acetic acid in ethyl alcohol, washed in distilled water, dried and cleaned with dry muslin cloth before use.

Anticoagulants

- **Ethylene diamine tetra acetic acid :** 1 mg of powder to 5 ml of blood.

- **Heparin :** 75 units for 10 ml. of blood.
- **Sodium oxalate 20% :** use @ 0.01 ml/ml of blood.
- **Sodium citrate 25% :** use @ 0.01 ml/ml of blood.

Collection of blood

Small amount of blood for making smears may be taken from the ear vein of horse, cattle, sheep, goat, pig, rabbit and dog. When a blood sample from a bird is required, the vein near the elbow joint under the wing is punctured. The hairs from the area should be clipped and the part cleaned and disinfected with 70% alcohol or methylated spirit.

Thin blood smear

The site of the vein is cleared with non-fluffy cotton and ethyl alcohol to remove the contaminants and the slide is dried. The vein is punctured using a clean needle.

A small drop of blood, less than a pin's head is placed in the middle, near one end of the slide.

The slide is held firmly between the middle finger and thumb of the left hand and another clean slide with straight and smooth edges (spreader slide), is placed on the centre of the examination slide. The lower edge of the spreader slide is held at an angle of 30 to 45 degrees and is drawn up to make contact with the drop of blood and wait until drop of blood flows both end of the spreader slide. Draw the spreader slide away from the blood drop with a smooth rapid movement. This action results in thin and even blood smear. The film is dried by waiving it in the air but rapid drying under sunlight may cause artefacts. The examination slide in this position should be protected from fly, dust, moisture, etc. The identity with respect to its host etc. is recorded on the slide.

Points of a good blood film

- The film should occupy about 1/3 of the length of the slide.
- The greater part of it should consist of a uniform single layer of blood cells.
- The edges of the film should be as unbroken as possible.
- The film should not be so thin to break the continuity of the film.

Wet blood film

A wet blood film is used for the detection of living trypanosomes and microfilaria of filarial worms. Staining in this case is unnecessary because the movement of the trypanosomes make them apparent. The use of phase contrast microscope is especially useful for this purpose.

Procedure

A drop of blood is placed on a clean slide. The blood is covered with a clean, dry coverslip. The film is then immediately examined under the microscope using the high power objective.

Lymph gland biopsy smear

A lymph node smear is sometimes used in preference to a blood smear, for example during an investigation of theileriosis or even trypanosomiasis. Common lymph node used for biopsy is prescapular.

Procedure

A suitable superficial lymph node is selected and palpated so that the site is fully known. The site is shaved and cleaned with the help of alcohol; punctured by a sterile hypodermic needle and the material is gradually drawn into a clean syringe. The collected lymph fluid is ejected on a clean slide and thick smear is drawn with the help of a spreader.

Fixation of slides

- Fixation helps to preserve the material used for the preparation and also enables it to withstand damage during subsequent staining. Otherwise, the smears wouldddeteriorate, the cells may shrink or stretch due to osmosis or be digested by their own cellular enzymes; the material may also be affected by bacteria or fungi such as moulds. Chemical fixatives like methyl alcohol is used to fix them
- **Methyl alcohol:** This is suitable for blood films/smears. The slide is immersed in methanol for two minutes. If an aqueous stain is to be used, the slides must be dipped in water after fixation.

Procedure

Staining

A carefully stained preparation shows parts of structures well coloured with the dye and other parts faintly coloured. When two stains are used, either separately as in methylene blue and eosin or together as in Giemsa's staining, some parts will be coloured by one dye and other parts by the other e.g. the nuclei of protozoa stained by Giemsa appear red and the cytoplasm blue. Various types of stains and their staining methods are described below :

1. Leishman's stain

This stain has a poor keeping quality in hot climate, so it is better to prepare a fresh stain from the powder every month or so.

Staining procedure

Ten drops of Leishman's stain are poured on the slide, rocked gently, and allowed to act for one minute. Twenty drops of slightly alkaline (pH 7.2) distilled water is added to the slide and is mixed by rocking the slide gently. Ten to 20 minutes are allowed for staining. The slide is washed by stream of distilled water in horizontal position until the smear looks pink. Thereafter, the slide is kept in a vertical position so that it drains and dries. It can be examined under a microscope in oil immersion without a coverslip, however, zero number coverslips can be used if permanent mount is needed. Fixation is not required in Leishman's staining procedure because methyl alcohol is already mixed in Leishman's stain.

2. Giemsa's stain

The stain introduced by Giemsa is a modification of a stain made by Romanowsky who mixed methylene blue and eosin so that three colours red, purple and blue were present in the stained slide. Giemsa's stain is a Romanowsky stain containing methylene blue, eosin, methylene azure, glycerol and methyl alcohol. Nowadays the stain is normally obtained in a concentrated form and requires dilution before use.

Preparation of buffer

I) KH_2PO_4 (Potassium dihydrogen orthphosphate) - 3.0 gm.

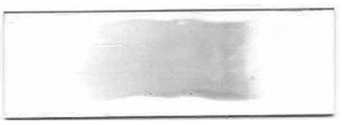
II) $Na_2HPO_4 12H_2O$ (Disodium hydrogen orthophosphate) - 15.0 gm.

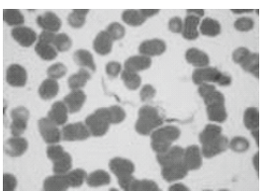
Add (i) to half the volume of water, dissolve, then add (ii) and make up to 5 litres, dissolve, mix well and check pH which should be 7.2 and if not, discard and make five litres afresh.

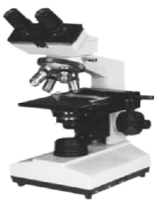
Staining procedure

A thin smear is made, allowed to dry thoroughly and fixed in methyl alcohol for two minutes. The stain is diluted with buffer in a ratio of 1:9. The slides are then kept on a staining rack and sufficient diluted stain is poured to cover the smear. It is kept (covered with some tray etc. in summer to avoid evaporation) for 45 minutes. The slides are flooded with buffer/distilled water till the smear is just pink (usually for one minute). The slides are dried in the air and examined under the microscope under oil immersion

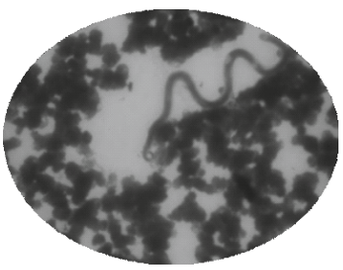
The artifacts are liable to camouflage the precision of the microscopic findings. To avoid this, the slides should be placed vertically in the copulin jar having the required stain or preferably stained on a horizontal rack, diluted and washed with a buffer in the same position. If the stain is poured off, the scum is liable to stick to the slide and forms artifacts.



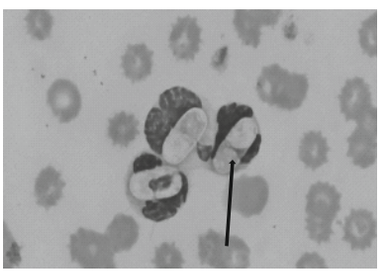




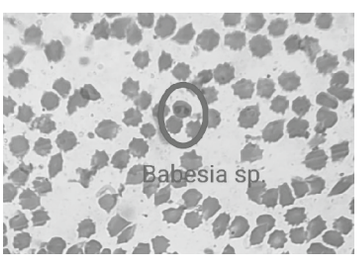
Trypanosoma



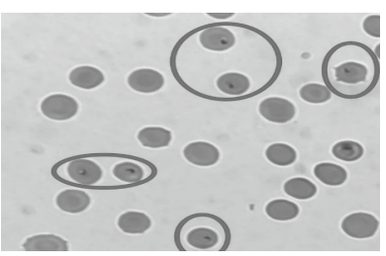
Microfilaria of *Dirofilarial immitis*



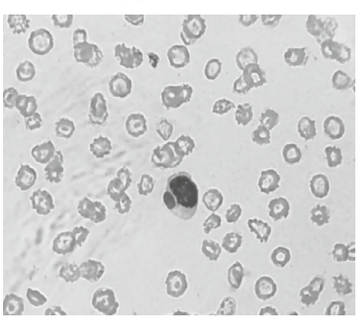
Hepatozoon canis inside neutrophil



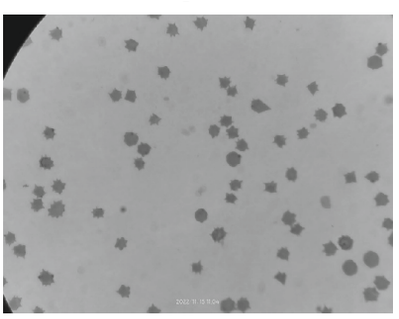
Babesia spp. inside RBCs



Theileria *sp. inside RBCs*



Ehrlichia *spp.*



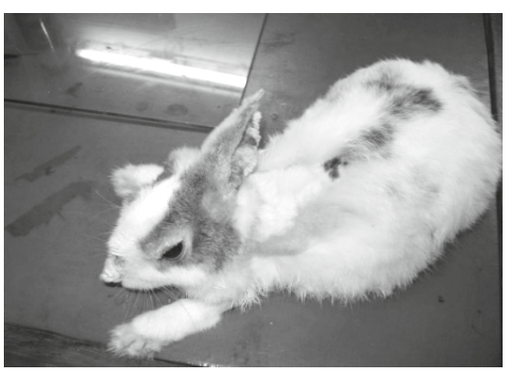
Anaplasma marginal

C. Skin Scarping Method

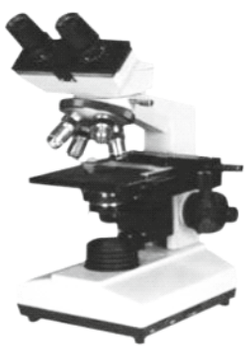
Used for the diagnosis of parasitic mites. Mites causing a disease in animals called mange. Mange includes alopecia, dermatitis etc.

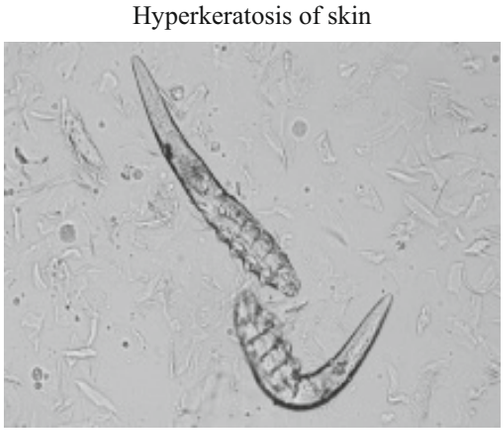
Procedure

- Clip the hairs around lesion and scrap the edges of skin lesions with the help of a blunt scalpel or blade to extent that a little blood begins to ooze through the abrasions. Collect the scraping materials on a plane paper.
- Skin scrapings should be taken from moist part near the edge of the lesion avoiding the inclusion of large amount of dry crust, hair or wool. It is also desirable to take scrapings from more than one lesions.\
- Boil the scraping materials in 10 percent KOH to dissolve debris.
- After cooling pour the materials into centrifuge tube and centrifuge for 2 minutes at 2000 rpm.
- Take one drop of sediment on a glass slide , cover with cover slip and examine under low power (40X) of microscope for the presence of mites.

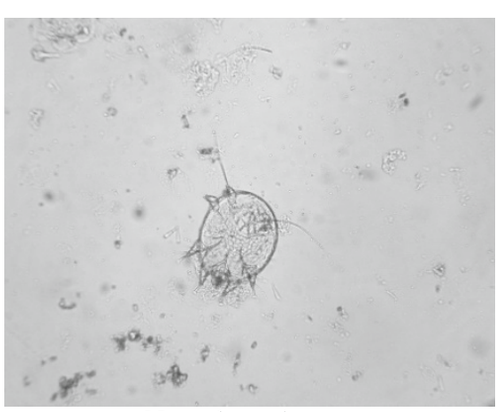


Hyperkeratosis of skin





Demodex mites



Notoedres mite

Estrus Synchronization and Breeding Management of Cattle with Special Reference to Artificial Insemination

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Effective reproductive management is a prerequisite for profitability in dairy and beef farming. Despite advances in management, postpartum anestrus, silent estrus, and poor heat detection continue to limit reproductive efficiency. Estrus synchronization, in combination with AI, allows farmers to plan breeding more effectively, reduce dependency on estrus observation, and exploit superior genetics.

1. Estrus Synchronization

A. Comparative Reproductive Physiology: Cattle vs. Buffaloes

Feature	Cattle	Buffaloes
Estrous cycle length	21 days	21 days (range 18–24 days)
Estrus duration	12–18 h	6–30 h (often shorter, less intense)
Ovulation	24–30 h after onset of estrus	24–30 h after onset, but variable
Seasonality	Non-seasonal breeder	Seasonal breeder (peak in winter, poor summer cyclicity)
Estrus signs	Clear, more pronounced	Often silent or weak, difficult to detect

B. Estrus Synchronization Protocols

a). PGF2α Based Protocols

- **Cattle:** Single or double injections of PGF2α cause luteolysis if a functional CL is present.
- **Buffaloes:** Response is less predictable due to lower cyclicity, especially in summer. Double injection protocol (11–14 days apart) improves synchronization.

b). Progestagen/Progesterone Based Protocols

- Devices: **CIDR (Controlled Internal Drug Release), PRID, intravaginal sponges.**
- Mimic luteal phase; withdrawal induces estrus.
- Effective in anestrus buffaloes and postpartum cows.

c). Ovsynch Protocol (GnRH–PGF2α–GnRH–FTAI)

- Widely adopted in cattle; suitable for fixed-time AI.
- Buffaloes respond, but conception rates lower than in cattle.
- **Modified Ovsynch (Double-Ovsynch, Cosynch)** used for better synchronization in buffaloes.

d). GPG and GPE Protocols

- **GPG:** GnRH–PGF2α–GnRH.
- **GPE:** GnRH–PGF2α–Estradiol.
- Effective in overcoming silent estrus in buffaloes.

C. Factors Affecting Success

Factor	Cattle	Buffaloes
Body condition score	Critical	critical; undernutrition worsens anestrus
Postpartum interval	>45 days	>60–90 days (longer postpartum anestrus)
Season	Minor effect	Strong influence (summer anestrus common)
Heat stress	Reduces estrus intensity	Major cause of silent estrus, poor follicular growth

2. Breeding management

Breeding management in cattle refers to the scientific and systematic approach to maximize reproductive efficiency, genetic improvement, and overall herd productivity. It includes timely detection of estrus, proper mating strategies (natural service or artificial insemination), semen handling, pregnancy diagnosis, calving management, and postpartum care. Efficient breeding management is crucial to ensure optimum calving interval (~12–13 months), higher milk production, and genetic progress.

The primary objectives of breeding management in cattle are to achieve a shorter calving interval of about 365–400 days, ensure optimum conception rates through efficient estrus detection and timely insemination, reduce the incidence of reproductive disorders such as anestrus, repeat breeding, and dystocia, and introduce genetic improvement by the use of proven sires through artificial insemination. These measures collectively contribute to the economic sustainability of dairy farming, which is central to enhancing productivity in cattle-based enterprises.

A sound understanding of reproductive physiology forms the cornerstone of successful breeding management. Heifers generally attain puberty between 12 and 18 months of age, though body weight is considered a more reliable indicator than age. In indigenous breeds, heifers typically reach puberty at 250–300 kg, while in

crossbred cattle the threshold is slightly higher at 280–320 kg. The estrous cycle in cattle averages 21 days, ranging from 18 to 24 days, with estrus lasting 12–18 hours. Ovulation occurs approximately 24–30 hours after the onset of estrus. The optimum time for insemination is mid to late estrus, often guided by the AM-PM rule, which recommends inseminating cows observed in heat during the morning in the evening and vice versa.

Efficient estrus detection is one of the most critical aspects of breeding management. Behavioral and physical signs of heat include restlessness, bellowing, mounting or standing to be mounted (the most reliable indicator of standing estrus), clear and stringy vaginal mucus discharge, swollen vulva, a temporary drop in milk yield, and frequent urination. To improve the accuracy and efficiency of heat detection, several aids are employed in modern systems, such as heat detection cards, pedometers, activity monitors, tail painting, and the use of teaser bulls.

Cattle breeding is carried out through two main methods: natural service and artificial insemination. Natural service, although still practiced in rural areas and with indigenous breeds, carries limitations such as disease transmission, inefficiency in large herds, and challenges in achieving genetic improvement. In contrast, artificial insemination (AI) has emerged as the preferred method due to its ability to utilize semen from proven sires, stored in fresh, chilled, or frozen form in liquid nitrogen at –196°C. AI not only reduces the cost of maintaining breeding bulls but also helps in controlling the spread of reproductive diseases such as brucellosis, trichomoniasis, and campylobacteriosis. Moreover, AI facilitates faster genetic gain and has revolutionized modern cattle breeding.

Breeding strategies must also consider the appropriate age and weight at first breeding. Ideally, heifers should be bred at 15–18 months of age, provided they have attained the required body weight. Breeding too early, before physiological maturity, results in stunted growth, dystocia, and reduced milk yield, while delayed breeding leads to significant economic losses. Management of the calving interval is another crucial aspect, with the ideal interval being 12–13 months. Cows typically exhibit postpartum estrus within 40–60 days after calving, and the second or third estrus postpartum is considered the best time for breeding. Estrus synchronization protocols such as Ovsynch, prostaglandin (PGF2α), and controlled internal drug release (CIDR) devices have been widely adopted to facilitate fixed-time artificial insemination (FTAI), especially in large herds where dependence on heat detection can be limiting.

Pregnancy diagnosis and monitoring form another integral part of breeding management. Rectal palpation remains the most common and reliable method,

usually accurate after 45–60 days of gestation. Ultrasonography, however, has enabled earlier diagnosis as early as 25–28 days post-breeding, while progesterone assays offer an indirect means of confirming pregnancy. Early and accurate pregnancy diagnosis is important for timely rebreeding of non-pregnant cows, thereby reducing reproductive wastage.

Nutrition and overall health status have a profound impact on reproductive efficiency. Balanced rations containing adequate energy, protein, minerals, and vitamins are essential for successful breeding. Negative energy balance, particularly in early lactation, often leads to delayed estrus or silent heat. Trace minerals such as phosphorus, copper, zinc, and selenium, along with vitamins A, D, and E, are critical for maintaining fertility. Furthermore, vaccination programs targeting reproductive diseases like brucellosis, infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), and leptospirosis should be incorporated into herd health and breeding programs.

Accurate record-keeping is indispensable for evaluating and improving breeding management. Key records should include the date of estrus detection and insemination, details of the sire used, conception outcomes, calving dates, and inter-service intervals. Important reproductive indices that serve as benchmarks for herd fertility include a conception rate of 40–50% under AI, services per conception of 1.6–2.0, an ideal calving interval of 12–13 months, and age at first calving of 24–30 months. Maintaining these standards ensures efficient breeding management and contributes to the overall profitability and sustainability of dairy farming

2. Artificial Insemination in Cattle

Artificial insemination (AI) is the most widely practiced assisted reproductive technology in cattle, and it has transformed both dairy and beef production systems. By enabling the use of semen from genetically superior bulls across large herds, AI has contributed significantly to rapid genetic improvement, disease control, and overall breeding efficiency. Its adoption has allowed dairy farmers to improve milk yield and reproductive performance while reducing the need for maintaining breeding bulls on the farm. In countries such as India, where the majority of livestock owners are small and marginal farmers, AI also provides an affordable method for enhancing the productivity of indigenous breeds.

Objectives of Artificial Insemination

The primary objective of AI is to accelerate genetic progress by allowing widespread use of elite sires, thereby improving traits such as milk yield, growth, fertility, and

disease resistance. AI also reduces the spread of venereal diseases that are often associated with natural mating, and it eliminates the risks and costs of maintaining bulls, which can be difficult to handle and expensive to feed. Another important objective is to facilitate large-scale breeding programs, including estrus synchronization and fixed-time insemination, which allow efficient use of semen in herds of varying sizes. AI also enables long-term storage and transport of semen across different regions, ensuring year-round access to superior germplasm.

Anatomy and Physiology Considerations

A sound understanding of bovine reproductive anatomy and physiology is critical for successful insemination. The female reproductive tract consists of the vulva, vagina, cervix, uterus, and ovaries. Among these, the cervix, which has four to five annular rings, is the major site that the insemination instrument must pass through before semen can be deposited. Ovulation generally occurs about 24 to 30 hours after the onset of standing estrus, and therefore, correct timing of insemination is crucial to maximize conception rates.

Techniques of Artificial Insemination

The recto-vaginal technique is the most common method of AI in cattle. In this method, the cow is properly restrained, and the vulva is cleaned to maintain hygiene. The semen straw is thawed in warm water at 37 °C for about 30 to 40 seconds before loading into the insemination gun. The inseminator then inserts the gun into the vagina and carefully advances it through the cervix while guiding its passage using the hand introduced into the rectum. Once the tip of the gun reaches the uterine body, just beyond the cervix, the semen is slowly deposited. This technique, when performed correctly, ensures the semen is released at the ideal site for fertilization.

Timing of Insemination

Proper timing of AI is essential to achieve high conception rates. The commonly followed AM-PM rule states that cows showing standing estrus in the morning should be inseminated in the evening, and those detected in the evening should be inseminated the following morning. This rule is based on the interval between estrus onset and ovulation, ensuring that sperm are present in the female reproductive tract at the time of ovulation. In fixed-time insemination programs, such as those following Ovsynch protocols, insemination is performed at predetermined times following hormonal synchronization, which eliminates the need for visual estrus detection.

Advantages of Artificial Insemination

Artificial insemination provides several advantages over natural mating. It allows the rapid spread of superior genetics across herds and regions, leading to significant improvements in milk yield and growth rates. It also reduces the cost of maintaining breeding bulls and prevents the spread of sexually transmitted infections. Furthermore, semen can be stored for extended periods in liquid nitrogen, enabling its use in breeding programs at any time of year. AI can also be integrated with modern reproductive technologies such as estrus synchronization, sexed semen, and embryo transfer to further enhance reproductive efficiency and farm profitability.

Challenges in AI Adoption

Despite its advantages, the widespread adoption of AI faces certain challenges, particularly in developing countries. Accurate detection of estrus remains a major hurdle, as silent heat or weak estrus expression is common in high-yielding dairy cows and buffaloes. The success of AI also depends on the availability of skilled technicians, which is often limited in rural areas. Additionally, maintaining the semen cold chain from the laboratory to the field is logistically demanding. Awareness among farmers about the benefits of AI and proper management practices is still lacking in many regions, which affects the overall success rates of the program.

Future Perspectives

The future of AI in cattle is promising, with several innovations on the horizon. The use of sex-sorted semen will allow farmers to predetermine the sex of offspring, which is especially valuable in the dairy industry where female calves are preferred. Genomic selection will further accelerate genetic improvement by identifying elite sires at an early age. Integration of AI with precision livestock farming tools, such as automated estrus detection systems and hormonal monitoring devices, will help overcome the challenges of heat detection and improve conception rates. Combining AI with embryo transfer and in vitro fertilization will also open new possibilities for genetic advancement in cattle.

Procedure of Embryo Transfer Technology in Bovines

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Embryo transfer (ET) technology in bovines is a reproductive technique which is generally used to propagate desirable genetic traits by transferring embryos from a superior donor cow to recipient cows. It's a one of the most important component of assisted reproductive technologies aimed at increasing the reproductive rate of females of superior genetic merit, especially in dairy cattle. In cows generally one ovum is ovulated during estrous cycle of animal and one successful conception confirmed at the end. However for the ET programme multiple embryos are recovered with help of hormonal administration. So we got multiple embryos and transferred these embryos to different recipient cows and got many calves from one donor cow in a year.

Steps Involved In Embryo Transfer: there are many steps involved in ET programme. These are as follows:

1) Selection of donor 2) Selection of recipients 3) Estrus synchronization of donor and recipients 4) Superovulation (SOV) of donor (release of multiple eggs at single estrus) 5) Artificial insemination of donor 6) Embryo collection 7) Evaluation of embryos 8) Transfer of embryos.

1. Selection of Donor: Donor cow in ET programme is selected on the basis of given criteria below

- ✓ Superior individual performance
- ✓ Good productive performance of offspring
- ✓ Regular Cyclicity
- ✓ Ovaries must be free (No adhesions)
- ✓ Intact tubular genitalia (free from any abnormalities)
- ✓ Younger (4-8 years of age)
- ✓ Healthy and have good body weight
- ✓ Must have calved at least 60 days back (best 90-100 days postpartum)
- ✓ Normal postpartum history
- ✓ A history of no more than two breeding per conception

- ✓ Previous calves having been born at approximately 365 day interval

2. Selection of Recipients: Recipients cow in ET programme is selected on the basis of given criteria below

- ✓ Healthy, free from infection and have good body weight.
- ✓ Regular cyclicity.
- ✓ Intact genitalia (free from any sort of abnormalities)
- ✓ Must have good cyclic CL of desired stage at the time of embryo transfer
- ✓ Exhibit calving ease, and that have good milking and good mothering ability.

3. Estrus Synchronization of Donor

The donor cow should be synchronized to bring into estrus or should have palpable CL on the ovary from the natural estrus. For this, any of the synchronization protocols can be used viz. Ov-synch, Co-synch, select synch hybrid synch, heat synch, PG protocols etc.

4. Superovulation of Donor Cow

Procedure for increased ovulatory response by administration of hormones (gonadotropins) to produce several ova instead of one which is normally produced at each estrus. This large number of ova is later on fertilized and embryo produced can be transferred to the recipients. The basic principle of superovulation is to stimulate extensive follicular development through the use of a hormone preparation, which is given IM or SC with FSH activity.For optimum response gonadotropin treatment is initiated during mid luteal phase of estrus cycle i.e. on days 9-14 of estrous cycle (Day 0 is estrus). Donor cows can be superovulated repeatedly at approximately 6-8 weeks interval. Generally FSH hormone is given morning and evening at 12 hours interval in 8 divided doses intramuscularly for superovulation.

5. Insemination of Donor (A.I.)

Donor should be inseminated artificially 2-3 times at 12 hours interval after the onset of estrus. This is required because ovulation can occur over an extended time period. Fresh semen is preferred. If frozen semen then use double insemination dose at each insemination.

6. Embryo Recovery

Embryos can be collected by Non-Surgically by Trans Cervical Method.It involves 2 ways or 3 ways Foley or Woerllein catheter which allows flushing fluids to pass into

the uterus and at the same time allows fluids to be returned from the uterus to a collecting receptacle. A small balloon near the end of catheter can be inflated just inside the uterine horn to prevent the flushing fluid from escaping through the cervix.Collection of bovine embryos should be made at 6-8 days post-breeding at compact morula or blastocyst stage. The best flushing medium for embryo collection in most of the species is modified Dubecco's phosphate buffer saline. NS can be used in its absence.

Give large doses of intrauterine antibiotics to prevent infection. Injection of PGF2α is also recommended to speed recoveries of ovaries and to prevent pregnancy, if viable embryos are not dislodged by the flushing.

7. Evaluation of Embryos

After collection and before transfer to the recipients, the embryos are evaluated under sterezoome microscope at 50 to 100x magnification. Day 7 bovine embryos (compact morulla or blastocyst) are about150-190µm in diameter and are still within the zona pellucida. Embryos are graded based on following characteristics

- ✓ Compactness of the cells
- ✓ Regularity of cells
- ✓ Variation in cell size
- ✓ Colour and texture of cytoplasm
- ✓ Presence of vesicles, extruded cells, cellular debris

8. Transfer of Embryo (Introduction to Recipients)

Recipients should be in estrus within 12 hrs. of the donor so that is should possess good CL at the time of transfer. To maximize success rate of transfer, the recipient's estrus should be in synchrony with that of the donor. For the process of transferring embryos the recipient is palpated to determine the presence and location of the CL (Rt. Ovary vs. Lt. Ovary). Recipient is administered an epidural anesthesia (2% Lignocain) to relax the muscles in the pelvic area.

Flushed embryos after inspection are loaded into ET straw. If the embryo is frozen it is thawed in warm water bath (92^0F) for <30s and placed in ET gun and covered with sterile sheath.The ET gun is passed through the vagina, cervix and into the uterine horn on the side as the CL. The embryo is deposited 1/3 the way up to the uterine horn. The pregnancy rate will be high when day of estrus of recipients and donor are within 24 hours.The embryos are typically transferred on day 7 of the estrous cycle to the recipients.

Advantages of ETT

- ✓ Increase the number of offspring sired from superior females.
- ✓ Results in faster genetic progress.
- ✓ Obtain offspring from old or injured animals incapable of breeding or calving naturally.
- ✓ Increase farm income from sale of embryos.
- ✓ Export/import of embryos is easier than with live animals

Innovative Approaches to Bandaging Techniques in Veterinary Practice

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Traditional bandaging, while serving a protective role, often fall short in addressing the complex and dynamic nature of wound healing, especially in cases of chronic wounds. Bandaging is the process of applying a bandage to an injury or a part of the body. This is often done to hold a dressing in place, provide support, or control bleeding. Additionally, bandaging can be used to secure a splint or provide compression. Innovative bandaging techniques in animals focus on enhancing protection, promoting healing, and minimizing complications.Innovative approaches in bandaging techniques are revolutionizing wound care by embracing advanced materials, smart technologies, and interdisciplinary strategies to facilitate faster, more effective, and personalized healing. These techniques include specialized materials like hydrogels and alginates for wound management, anchoring methods for marine animals, and pressure bandages for specific injuries. Additionally, advancements in bandage application, such as the use of tie-over bandages and techniques for different body parts, contribute to improved outcomes

Principles of bandaging: General technique for limb bandaging

- Prepare the area: Wounds should be clipped wide to check for additional wounds or allow the placement of stay sutures for a tie-over bandage. The peri-wound area should be cleaned with chlorhexidine gluconate 4% diluted with 25 to 50 mL of saline. When appropriate, the wound should be lavage with sterile saline using a high-pressure lavage system. Larger volumes of lavage should be used in contaminated wounds. Aerobic and anaerobic culture specimens of the wound should be taken to determine the appropriate antimicrobial therapy, but they should be taken after lavage has been performed. Debridement can be performed with Metzenbaum scissors or a surgical blade when indicated.
- Apply stirrups (optional): These are strips of tape placed longitudinally to help prevent the bandage from slipping down the limb.
- Apply the primary layer: Cover the wound with a suitable dressing.
- Apply the secondary layer: Wrap the limb with padding (e.g., cast padding or

cotton) from distal to proximal (towards the body), overlapping by 50%.

➢ Apply the tertiary layer: Wrap the cohesive bandage (Vetrap or similar) in the same direction, overlapping by 50%, ensuring it's snug but not too tight.

➢ Check the tension: Ensure you can fit two fingers comfortably under the top of the bandage.

➢ Leave toes exposed: If possible, leave the middle two toes visible to monitor for swelling.

Bandaging Techniques:

✓ **Robert Jones:** used for severe limb injuries, involving a thick layer of padding for immobilization and compression. Step by Step Robert Jones Bandage are:

- Clip a large area surrounding the wound to expose the wound edges and to check for any additional wounds.
- Clean the peri-wound area with dilute chlorhexidine and lavage with saline to remove debris.
- Dry the surrounding area with gauze.
- Choose an appropriate topical therapy/primary layer and apply in a sterile fashion.
- Apply cast padding.
- Apply conform gauze.
- Apply bandage tape.
- Apply elastic tape.

✓ **Tie-over bandage:** versatile bandage that can be applied to various locations on the body using sutures to secure it.

✓ **Paw bandage:** requires special attention to padding between the toes and ensuring the bandage doesn't restrict circulation to the paw.

✓ **Splinting:** incorporating a splint within the bandage layers can provide additional immobilization for fractures.

✓ **Velpeau sling:** is applied in order to prevent the dog from weight bearing on that forelimb and to immobilize the shoulder joint, for a period of time. Like most slings, it should not be left on for more than 7-10 days.

✓ **Ehmer sling:** It is a specialized bandage used in dogs to stabilize the hip joint after injuries like luxation (dislocation) or certain fractures. It keeps the hind limb flexed, internally rotated, and prevents weight-bearing, promoting healing and preventing further injury.

Key areas where innovation is driving the evolution of wound bandaging

These innovative bandaging techniques represent a paradigm shift in wound care, moving from a generic one-size-fits-all approach to a more personalized, proactive, and technology-driven approach that holds significant promise for improved patient outcomes and reduced healthcare burdens.

1. Smart bandages and dressings with monitoring capabilities

Researchers are developing intelligent hydrogel dressings that can monitor wound parameters like pH, temperature, and glucose levels in real-time. Integrating these dressings with flexible electronics and sensors allows for wireless data transmission and remote monitoring, facilitating timely interventions and improved patient outcomes. These cutting-edge bandages integrate sensors and embedded electronics to monitor various wound parameters in real-time, including:

- **Temperature**: Provides insights into inflammation, infection, and blood flow.
- pH levels: Crucial indicator of wound healing progression and potential bacterial growth.
- **Moisture levels:** Maintains a moist environment conducive to healing while preventing maceration.
- **Oxygen levels:** Assesses tissue oxygenation, essential for cell growth and regeneration.
- **Biomarkers:** Detects the presence of specific molecules like uric acid or lactate, indicative of inflammation or infection.

  These smart bandages can wirelessly transmit data to smartphones or other devices, allowing healthcare providers to remotely monitor wound progress and make timely adjustments to treatment plans.

2. Advanced materials and nanotechnology

Innovations in materials science are leading to the development of novel dressings with enhanced properties:

- Hydrogels, Hydrocolloids: and foams: These materials absorb exudate, maintain a moist wound environment, and can be customized to suit different wound types and exudate levels.These dressings help maintain a moist wound environment, which is crucial for optimal healing, especially for dry wounds.
- Nanofibers: Electrospun nanofibers mimic the natural structure of the extracellular matrix (ECM), providing a scaffold for cell growth, oxygen exchange, and sustained drug release.
- Bioactive dressings: Incorporating materials like collagen, chitosan, or honey,

these dressings actively participate in the healing process by stimulating cell proliferation, reducing inflammation, and preventing infection.

- Drug-loaded dressings: Can release antimicrobial agents, growth factors, or anti-inflammatory compounds directly at the wound site, optimizing drug delivery and minimizing systemic side effects.
- Stimuli-responsive materials: Smart polymers and nanoparticles that respond to changes in the wound environment (e.g., pH, temperature, enzyme activity) to trigger controlled drug release.

3. Bio-engineered skin substitutes and 3D bio-printing

Advancements in bio-engineered skin substitutes and 3D bioprinting are also being explored to create customized wound care products and implants tailored to the specific needs of individual patients. Useful for the cases with severe tissue loss, like burns or degloving injuries, free skin grafts are used to cover the wounds.

- ✓ **Customizable skin grafts:** Patient-specific skin substitutes can be 3D printed using the patient's own cells, leading to better compatibility and reduced risk of rejection.
- ✓ **Personalized wound dressings and scaffolds:** Tailored to the exact size, shape, and depth of the wound, ensuring optimal fit and therapeutic effect.
- ✓ **Integration of functionalities:** Can incorporate growth factors, antimicrobial agents, or even vascular channels to promote angiogenesis.

4. Regenerative medicine and cell-based therapies:

Harnessing the body's natural healing abilities, these approaches utilize:

- ✓ **Stem cell therapies:** Introduce stem cells into the wound environment to accelerate tissue regeneration, particularly beneficial for chronic wounds and severe burns.
- ✓ **Growth factor therapies:** Stimulate cell proliferation, migration, and angiogenesis to facilitate wound closure.
- ✓ **Bioengineered scaffolds:** Provide a framework to support cell adhesion, proliferation, and tissue regeneration, often mimicking the extracellular matrix.

5. **Alternative and supplementary approaches:**

- ✓ **Topical sprays:** These sprays can provide an antibiotic-free approach to managing superficial wounds, creating a protective barrier and promoting natural healing.
- ✓ **Spray and stay approaches:** For livestock, topical anesthetic and antiseptic

formulations are being developed to reduce pain, minimize bleeding, and provide antiseptic cover for open wounds.

✓ **Multimodal analgesia:** Combining local anesthetics and NSAIDs (non-steroidal anti-inflammatory drugs) can effectively manage wound pain, especially during debridement procedures.

6. Other innovative approaches:

- **Electric bandages:** Utilize low-level electrical fields to stimulate tissue growth and accelerate healing.
- **Telewound care:** Leverages telemedicine and remote monitoring technologies for expert consultation and continuous wound assessment, especially beneficial for patients in remote areas.
- **Acoustic pressure wave therapy:** Uses sound waves to enhance blood circulation, stimulate cell proliferation, and break down scar tissue.
- **Robotics:** Emerging applications include automated wound assessment and even robotic bandaging systems to streamline wound management procedures and enhance precision.

Take-Home Message:

- Cast padding cannot be put on too tight.
- Monitor for complications like swelling above or below the bandage, skin irritation, or changes in the wound's appearance.
- Prevent the animal from interfering with the bandage, potentially using an Elizabethan collar (e-collar).

Conclusion:

- Innovations in bandaging techniques for animals are constantly evolving, driven by the desire for improved healing outcomes, reduced complications, and enhanced animal welfare.

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Haemoparasitic Infections in Dogs: Case Discussions and Lessons for Practice

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Haemoparasitic diseases in dogs are a major group of vector-borne infections caused by protozoan parasites that invade blood cells, leading to anemia, immunopathological changes, and systemic illness. They are transmitted mainly by hematophagous vectors such as ticks, fleas, and sandflies, contaminated needles, surgical instruments and though blood transfusion. In tropical and subtropical regions, where myriad of vector populations are available, these infections are an important cause of morbidity and mortality in dogs. Increasing movement of companion animals has further spread these diseases beyond their traditional endemic zones, making them a global veterinary concern.

The most common haemoparasitic diseases in dogs include **babesiosis, ehrlichiosis, anaplasmosis, hepatozoonosis, trypanosomiasis, and leishmaniasis.** Canine babesiosis, caused by *Babesiacanis* and *Babesiagibsoni*, is the most frequently reported and manifests with hemolytic anemia, jaundice, fever, and in severe cases, multiorgan dysfunction. Hepatozoonosis (*Hepatozooncanis* and *H. americanum*) is characterized by chronic wasting, fever, and muscle pain. Canine leishmaniasis (*Leishmaniainfantum*), a zoonotic infection, occurs in cutaneous and visceral forms and poses significant public health risks. In endemic areas, *Trypanosoma evansi* (surra) may also infect dogs, adding to the spectrum of canine haemoprotozoan diseases.

Pathogenesis of these infections primarily involves **erythrocyte destruction, immune-mediated hemolysis, and inflammatory responses.** Clinical signs are often vague—fever, lethargy, anorexia, lymphadenopathy, hepatosplenomegaly, and anemia—making diagnosis difficult. Laboratory confirmation through blood smear examination, serological assays, and molecular methods such as PCR is essential. In endemic zones, **co-infections** with multiple haemoparasites are common, further complicating diagnosis and management.

Epidemiologically, disease prevalence is influenced by **vector density, climate, host immunity, and management practices.** In India and similar regions, the burden is high due to heavy infestations of *Rhipicephalussanguineus* (brown dog tick), the

major vector for babesiosis and hepatozoonosis. Poor tick control and the presence of free-roaming dogs further enhance transmission risk. Importantly, some of these infections, especially leishmaniasis, are**zoonotic**, creating additional public health challenges.

1. Case Report: Canine Ehrlichiosis

Introduction

Canine ehrlichiosis is a tick-borne disease caused by *Ehrlichiacanis*, an obligate intracellular rickettsial organism transmitted primarily by *Rhipicephalussanguineus* (brown dog tick). It is widely prevalent in tropical and subtropical regions, with German Shepherds and Dobermans considered highly susceptible. The organism infects monocytes, forming morulae within them. Clinically, it is characterized by fever, epistaxis, lymphadenopathy, thrombocytopenia, anemia, depression, and weight loss. Chronic forms may lead to pancytopenia and severe debility.

Case Presentation

A 10-year-old mixed-breed female dog weighing 21 kg was presented with a history of anorexia, vomiting, progressive weight loss, dullness, depression, and recurrent epistaxis. The owner reported tick infestation for the past two weeks despite routine deworming and vaccination.

Clinical Examination

The dog was febrile (103.8 °F), had pale mucous membranes, popliteal lymphadenopathy, and a heart rate of 92/min.

Clinical signs observed:

- Fever
- Epistaxis
- Anorexia
- Vomition
- Depression and dullness

Diagnostic Workup

- **Hematology:**Hb (10.8 g/dl), RBC count (6.44 × 10 /µl), PCV (32.5%), marked thrombocytopenia (0.54 lakh/µl), and leukocytosis (20,700/mm³).
- **Biochemistry:** BUN (6 mg/dl), Creatinine (0.85 mg/dl), SGPT (218 IU/L), SGOT (46 IU/L).

- **Blood smear:** Presence of *Ehrlichiacanis* morulae in monocytes.

Treatment and Outcome

The dog was treated with Doxycycline (200 mg IV, diluted in 200 ml NS daily for 5 days, later switched to oral therapy for 21 days) along with supportive therapy including pantoprazole, liver protectants (Lisybin), hematinic (Advaplat), vitamin injections, and diuretics (Lasix). Hemostatic therapy (Botropase) was administered as required for epistaxis. After 5 days, the dog showed remarkable improvement in appetite, activity, and cessation of nasal bleeding.

Discussion

This case highlights the acute form of canine ehrlichiosis, which is often characterized by fever, thrombocytopenia, bleeding tendencies, and elevated liver enzymes. The marked leukocytosis and severe thrombocytopenia were consistent with ehrlichial infection. Doxycycline remains the drug of choice and was highly effective in this case, although relapses can occur if treatment duration is inadequate. The role of supportive care and vector control (acaricides, tick prevention) is equally important in management. Early diagnosis and timely intervention are critical to prevent progression to chronic ehrlichiosis, which carries a poor prognosis due to bone marrow suppression and pancytopenia.

2. Case Report: Canine Babesiosis

Introduction

Canine babesiosis is a tick-borne haemoprotozoan disease caused by *Babesiacanis* (large form) and *Babesiagibsoni* (small form). The parasite invades erythrocytes, leading to intravascular hemolysis, anemia, jaundice, hemoglobinuria, and systemic illness. It is transmitted mainly by *Rhipicephalussanguineus* and can also spread via dog bites and transplacental transmission (especially *B. gibsoni*). Clinical signs vary from mild illness to severe, life-threatening disease depending on the parasite species, host immunity, and concurrent infections.

Case Presentation

A 2-month-old male Golden Retriever pup weighing 3 kg was presented with a history of inappetence, vomiting, distended abdomen, hematuria, and lethargy. The owner reported gradual worsening of symptoms over 4–5 days.

Clinical Examination

On examination, the pup was febrile (103.6 °F), tachycardia (143/min), dull, with pale mucous membranes, icterus, distended abdomen, and rough hair coat.

Diagnostic Workup

- **Blood smear:** Revealed *Babesiagibsoni*trophozoites inside RBCs.
- **Hematology & Biochemistry:** Severe anemia (Hb 5g/dl), low platelet count (94,000/µl), reduced PCV, elevated hepatic enzymes, and jaundice.

Treatment and Outcome

The pup was treated with IV fluids (Normal saline), doxycycline, clindamycin, supportive injections (pantoprazole, vitamin B12, diuretics), and metronidazole. Fipronil spot-on was applied for tick control. Nutritional support including pomegranate juice was also recommended. On follow-up, the pup showed gradual recovery: Hb improved to 11.8 g/dl, platelet count normalized (193,000/µl), and the parasite became undetectable on blood smear.

Alternative protocols discussed include imidocarbdipropionate (6.6 mg/kg IM) for *B. canis*, and atovaquone (13.3 mg/kg PO) with azithromycin (10 mg/kg PO) for *B. gibsoni*.

Discussion

This case demonstrates classical acute *Babesiagibsoni* infection in a young pup with severe hemolytic anemia, jaundice, and hemoglobinuria. *B. gibsoni* infections are often more chronic and relapsing compared to *B. canis*, and treatment is more challenging due to drug resistance. Combination therapy with atovaquone and azithromycin is considered most effective, although expensive and sometimes unavailable. In this case, supportive therapy combined with doxycycline,clindamycinand metronidazole provided significant improvement. Tick control measures are essential to prevent reinfection. Early intervention can be lifesaving, while delayed cases may progress to disseminated intravascular coagulation (DIC), renal failure, or death.

3. Case Report: Canine Anaplasmosis

Introduction

Canine anaplasmosis is an emerging tick-borne rickettsial disease caused by *Anaplasmaphagocytophilum* and *Anaplasma platys*, obligate intracellular bacteria belonging to the family *Anaplasmataceae*. Transmission occurs primarily through

the bite of the brown dog tick (*Rhipicephalussanguineus*). *A. platys* infects platelets causing cyclic thrombocytopenia, whereas *A. phagocytophilum* invades neutrophils leading to systemic illness. The disease presents with variable and often nonspecific clinical signs, making diagnosis challenging. Clinical suspicion, combined with hematology, biochemical tests, and serological/molecular assays, is essential for confirmation.

Case Presentation

A 6-year-old male dog was presented with a history of lethargy, fever, inappetence, and recurrent thrombocytopenia. The animal had been suffering from intermittent illness for the past few weeks. Owners reported vomiting episodes during therapy, and the animal had previously been infested with ticks.

Clinical Examination

On presentation, the dog showed depression, pyrexia (101.8–103 °F in different visits), pale mucous membranes, lethargy, and enlarged lymph nodes. Chronic weight loss and lameness were also noted.

Diagnostic Workup

- **Hematology:**Hb – 14.5 g/dl (within normal range); platelet count – 98 $\times 10^3/\mu l$ (marked thrombocytopenia).
- **Biochemistry:** Elevated SGOT; normal kidney function tests.
- **Blood parasite smear:** Negative for visible organisms.
- **SNAP 4Dx Plus test:** Positive for *Anaplasma* antibodies.

The diagnosis of canine anaplasmosis was confirmed based on persistent thrombocytopenia, compatible clinical signs, and positive serology.

Treatment and Outcome

Initial therapy included IV doxycycline (300 mg, diluted in normal saline), fluid support with Normal Saline and Ringer's Lactate, pantoprazole, vitamin B12 (CB12), and antipyretics (Meloxicam when temperature >103 °F). On subsequent visits, oral doxycycline (300 mg daily) was prescribed, along with hepatoprotective syrup (Liv 52), hematopoietic tonic (Althromb), vitamin E (Evion), and Samepet (S-adenosylmethionine + silybin) for liver support.

Over multiple follow-ups, the animal showed progressive improvement in appetite, activity, and temperature normalization. However, the SNAP 4Dx test remained

positive, which was explained to the owner as antibody persistence rather than active infection. Long-term oral doxycycline and supportive therapy were advised, along with strict tick control measures.

Discussion

This case highlights the diagnostic complexity of canine anaplasmosis. Blood smear examination often fails to reveal the organism due to intermittent parasitemia. Serological assays like SNAP 4Dx are valuable but detect antibodies, not active infection, which may persist after recovery. Persistent thrombocytopenia is a consistent clinical finding. Doxycycline remains the drug of choice and is effective against both *A. platys* and *A. phagocytophilum*. Supportive care, including hepatoprotectants, hematopoietic supplements, and fluid therapy, improves recovery. Relapses and chronic infections are possible, hence follow-up monitoring is crucial.

4. Case Report: Canine Trypanosomiasis

Introduction

Canine trypanosomiasis, also known as surra, is caused by *Trypanosoma evansi*, a hemoflagellate protozoan parasite transmitted mechanically by biting flies, primarily *Tabanus* and *Stomoxys* species. The disease occurs in tropical and subtropical regions and affects a wide range of domestic and wild animals. In dogs, it causes fever, progressive anemia, edema, nervous signs, and ultimately cachexia if untreated. Because of its nonspecific clinical signs and overlap with other haemoparasitic diseases, accurate diagnosis is essential for proper management.

Case Presentation

A dog was presented with a history of inappetence, progressive weakness, weight loss, and intermittent fever. The owner also reported dullness and reduced activity over the past few weeks. In some cases of canine trypanosomiasis, neurological manifestations such as ataxia, convulsions, and hind limb paralysis may occur, which are linked to the parasite invading the central nervous system.

Clinical Examination

On physical examination, the dog showed:

- Fever (>103 °F)
- Pale mucous membranes
- Enlarged lymph nodes

- Progressive emaciation
- Dullness and depression
- Possible edema of dependent parts (face, limbs, abdomen)

Diagnostic Workup

- **Blood smear examination:** Demonstrated the presence of *Trypanosoma evansi*trypomastigotes in peripheral blood.
- **Hematology:** Marked anemia (low Hb and PCV) and leukocytosis.
- **Biochemistry:** Mild elevation in liver enzymes due to systemic involvement.

Treatment and Outcome

The dog was treated with **Diminazine aceturate @ 3.5 mg/kg b wt,** along with supportive therapy with IV fluids, liver tonics, B-complex vitamins, and hematinics. The animal showed gradual improvement in appetite and activity following treatment. However, relapses are common, and long-term follow-up is advised.

Discussion

This case highlights canine trypanosomiasis as a differential diagnosis for fever, anemia, and weight loss in dogs, especially in endemic areas. The presence of *T. evansi* in blood smear confirms the disease, but parasitemia may fluctuate, making detection difficult. Advanced diagnostics such as ELISA or PCR improve sensitivity. Treatment is often effective if initiated early, but resistance and relapses remain challenges. Importantly, dogs act as reservoir hosts and can play a role in disease transmission to other animals.

Conclusion

Haemoparasitic diseases in dogs remain a serious threat to normal health due to widespread occurrence, diagnostic challenges, and therapeutic limitations. Effective control requires early diagnosis, specific therapy, supportive care and management. Moreover, **vector control strategiesis one of the important steps to reduce the incidence of these diseases.** Growing awareness among veterinarians and pet owners, coupled with improved diagnostic and preventive tools, becomes critical to reduce their impact on canine and public health hazards.

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Urine Analysis and Interpretation in Veterinary Laboratory

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Urinalysis is one of the most valuable, cost-effective, and non-invasive diagnostic procedures in veterinary medicine. It provides critical insights into renal function, urinary tract health, and systemic metabolic disorders. Since the kidneys filter blood, regulate electrolyte and water balance, and excrete metabolic waste, abnormalities in urine often reflect both renal and extra-renal pathology.Urine analysis comprises three major components:

1. Physical examination (color, odor, specific gravity, volume).
2. Chemical examination (pH, protein, glucose, ketones, bilirubin, blood, etc.).
3. Microscopic examination (cells, casts, crystals, microorganisms).

This chapter outlines the principles, techniques, and clinical interpretation of urine analysis in the veterinary laboratory.

2. Collection and Handling of Urine Samples:

2.1 Methods of Collection: Free catch (midstream voided sample): Common in dogs, cats, large animals; easy but may be contaminated.

Catheterization: Insertion of sterile catheter into urethra; useful in small animals and horses.

Cystocentesis: Needle puncture of bladder through abdominal wall; ideal for culture and sensitivity testing (minimizes contamination).

2.2 Timing of Collection

Morning sample is preferred (concentrated, acidic, best for detecting abnormalities).

2.3 Preservation and Handling

Fresh urine should be examined within 30–60 minutes.

Refrigeration (4°C) may preserve sample for up to 6–12 hours but can cause crystal precipitation.

Avoid chemical preservatives unless for long transport (e.g., thymol, toluene).

3. Physical Examination of Urine:

3.1 Colour: Normal colour is yellow/amber /wheat straw coloured and is related to

concentration of urochromes in Urine. Acidic urine is darker than alkaline urines. Blood can also be a contaminant that gets into the urine unintentionally during collection, such as from hemorrhoids etc. The depth of urine color is also a crude indicator of urine concentration:

Normal: Pale yellow to amber (urochrome pigment).

Abnormal:

Red/brown → hematuria, hemoglobinuria, myoglobinuria.

Dark yellow/orange → bilirubinuria, concentrated urine.

Milky white → pyuria, chyluria, lipiduria.

3.2 Appearance / Transparency

Clear: Normal fresh urine.

Cloudy/Turbid: Due to cells, crystals, mucus, bacteria, fat droplets.

3.3 Odour: Note the odour of urine sample normal order is urinoid (one of the volatile fatty acids).

Ammoniacal: Bacterial decomposition in urinary tract infection.

Fruity/sweet: Ketonuria (diabetes mellitus, starvation).

3.4 Volume: Record the amount of urine produced per day by normal animal and it is usually inversely proportional to the specific gravity. It is inversely related to specific gravity i.e. high volume with low specific gravity and low volume with high specific gravity exception to it are diabetes mellitus (high volume and high specific gravity, due to glycosuria) and terminal nephritis (low volume and low specific gravity). The amount of urine produced by a normal animal is dependent upon several factors like diet, fluid intakes climate, exercise and size and weight of the animal.

Polyuria: Chronic renal failure, diabetes mellitus, pyometra.

Oliguria/Anuria: Dehydration, obstruction, acute renal failure.

3.5 Specific Gravity (SG)

Measured with refractometer **or** urinometer**.**

Normal ranges:

- Dog: 1.025–1.045
- Cat: 1.035–1.060
- Horse, cattle, sheep, goat: 1.015–1.030

Interpretation:
Hyposthenuria (SG < 1.007): Kidneys actively diluting urine (diabetes insipidus, psychogenic polydipsia).
Isosthenuria (SG ~ 1.008–1.012): Kidneys not concentrating; suggests renal failure.
Hypersthenuria (SG > 1.030 in dogs, > 1.035 in cats): Dehydration, shock, diabetes mellitus.

4. Chemical Examination of Urine:
The most frequently performed chemical examination using urine samples are:
Specific gravity, pH, Protein, Glucose, Ketones, Blood, Bile pigments, Bile salts, Incican, Calcium, Urobilinogen, Leukocyte esterase, Nitrite.

4.1 pH: Normal pH of urine varies in different species and individuals depending upon the diet and metabolism. Animals on vegetable diet produce alkaline urine and animals consuming either a cereal diet with high protein or diet derived from animal's protein have acid urine.
Normal: Herbivores → alkaline; Carnivores → acidic; Omnivores → variable.
Acidic urine: Starvation, fever, acidosis.
Alkaline urine: Urinary tract infection (urease-producing bacteria), diet rich in plants.

4.2 Protein: The protein testmeasures the amount of albumin in the urine. Normally, there will not be detectable quantities. When urine protein is elevated, you have a condition called proteinuria. Albumin is smaller than most other proteins and is typically the first protein that is seen in the urine when kidney dysfunction begins to develop. The proteinuria can be detected by heat test, heller's test, Robert's test, Sulphosalicylic acid test or Albustix reagent.
Proteinuria:
- Pre-renal: Hemoglobinuria, myoglobinuria, fever.
- Renal: Glomerulonephritis, amyloidosis.
- Post-renal: UTI, inflammation.

4.3Glucose: Glucose is normally not present in urine. When glucose is present, the condition is called glucosuria is may be either due to an excessively high glucose concentration in the blood or a reduction in the "renal threshold." It can be tested by-

Benedict's test, Fehling's test or Clinitest reagent tablet.
Glycosuria: Diabetes mellitus, stress (cats), renal tubular damage.

4.4Ketones: Ketones (acetone, acetoacetic acid and beta hydroxy butyric acid) are not normally found in the urine. They are intermediate products of fat metabolism. They can form when an individual does not eat enough carbohydrates (for example, in cases of starvation or high-protein diets) or when an individual's body cannot use carbohydrates properly. When carbohydrates are not available, the body metabolizes fat instead to get the energy it needs to keep functioning. Ketonuria can be detected by Rothera's nitroprusside test.

- **Ketonuria:** Negative energy balance in ruminants (bovine ketosis, pregnancy toxemia in ewes), diabetes mellitus, prolonged starvation.

4.5 Bilirubin and Urobilinogen
- **Bilirubinuria:** Hepatic dysfunction, bile duct obstruction, hemolysis.
- **Urobilinogen:** Increased in hemolytic disease; absent in complete obstruction.

4.6 Blood/Hemoglobin
- **Hematuria:** Intact RBCs in urine (cystitis, urolithiasis, trauma).
- **Hemoglobinuria:** Free Hb due to intravascular hemolysis (babesiosis, leptospirosis, toxins).
- **Myoglobinuria:** Muscle injury (exertional rhabdomyolysis, trauma).

5.Microscopic Examination of Urine Sediment:
As part of a urinalysis, the urine sediment is centrifuged and examined microscopically for crystals, casts, red blood cells, white bloods cells, and bacteria or yeast. Because examination of urinary sediment provides a direct sampling of urinary tract morphology, it provides important information useful for both diagnosis and prognosis. Microscopic examination of urine sediment is usually performed in addition to routine procedures. This examination requires a degree of skill acquired through practice under the immediate supervision of an experienced technician. The specimen used for microscopic examination should be as fresh as possible. Red cells and many formed solids tend to disintegrate upon standing, particularly if the specimen is warm or alkaline.

5.1 Technique

- Centrifuge urine at 1500 rpm for 5–10 minutes.
- Discard supernatant and examine sediment under microscope (unstained or with Sternheimer stain).

5.2 Elements in Sediment

(a) Cells: Normally, there should be only an occasional blood cell in the urine (2-3 per high power field). If erythrocytes/leucocytes/epithelial cells are found, estimate their number per high-power field and report it.

RBCs: Round, colorless discs; increased in hematuria (trauma, stones, neoplasia).

WBCs: Granular, larger than RBCs; pyuria indicates infection or inflammation.

Epithelial cells: Squamous (contamination), transitional (cystitis, pyelonephritis), renal tubular (tubular damage).(b) Casts: These urinary sediments are formed by coagulation of albuminous material in the kidney tubules. However, may be collections of cells and debris that are formed in the tubules of the kidneys. Casts are cylindrical (cylinduria) and vary in diameter. The sides are parallel, and the ends are usually rounded. Casts in the urine always indicate some form of kidney disorder and should always be reported. If casts are present in large numbers, the urine is almost sure to be positive for albumin. Cast width is described as narrow (one to two red blood cells in width), medium broad (three to four red cells in width), and broad (five red blood cells in width). Broad casts usually indicate a significant reduction in the functional capacity of the nephron and indicate severe renal damage or "end stage" renal disease. The numbers of casts are reported as "number and type seen per low power field (LPF)". An example of a report might read: "5-10 hyaline casts/LPF."There are different types of casts. They are as follows:

- **Hyaline casts:** Non-specific, mild renal irritation.
- **Granular casts:** Tubular degeneration, nephritis.
- **Cellular casts:** Acute nephritis.
- **Waxy casts:** Chronic renal disease.
- **Fatty casts:**Lipiduria, nephrotic syndrome.

(c) Crystals: Urine contains many dissolved substances (solutes) – waste chemicals that the body needs to eliminate. These solutes can form crystals, solid forms of a particular substance in the urine. Crystals are identified by their shape, color, and by the urine pH. They may be small, sand-like particles with no specific shape (amorphous) or have specific shapes, such as needle-like. Crystals are considered

"normal" if they are from solutes that are typically found in the urine.

- **Struvite (triple phosphate):** Alkaline urine; UTI, urolithiasis.
- **Calcium oxalate:** Acidic urine; ethylene glycol poisoning, urolithiasis.
- **Ammonium biurate:** Seen in liver disease, portosystemic shunts.
- **Cystine crystals:** Rare; congenital metabolic defects.

(d) Microorganisms

- **Bacteria:** Cystitis, pyelonephritis.
- **Yeast:** Secondary contamination or infection in immunocompromised animals.
- **Parasites:**Capillaria plica, Dioctophymerenale, Trichomonas.

6. Clinical Interpretation:

Urinalysis findings should always be correlatedwith clinical history, physical examination, and hematological/biochemical parameters**.**

- **Renal failure:**Isosthenuria, proteinuria, casts, azotemia.
- **Urinary tract infection:** Pyuria, bacteriuria, alkaline urine, struvite crystals.
- **Hemolytic disease:**Hemoglobinuria, bilirubinuria, increased urobilinogen.
- **Metabolic/endocrine disorders:**
    - Diabetes mellitus → glycosuria, ketonuria, polyuria, high SG.
    - Ketosis in ruminants → ketonuria, hypoglycemia.
    - Liver disease → bilirubinuria, ammonium biurate crystals.

Conclusion:

Urine analysis remains an indispensable tool in veterinary diagnostics, offering insights into renal function, urinary tract health, and systemic diseases. Proper collection, handling, and systematic examination (physical, chemical, and microscopic) are essential for reliable interpretation. Although modern diagnostics include imaging, molecular biology, and immunoassays, urinalysis continues to be a cornerstone of clinical pathology, providing veterinarians with rapid and valuable diagnostic information.

Basics of ECG in Canine and Feline

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Electrocardiography (ECG) is a non-invasive diagnostic tool widely employed in veterinary cardiology to evaluate heart rate, rhythm, electrical conduction, and, to some extent, chamber size. In dogs and cats, ECG plays an important role in the diagnosis of arrhythmias, conduction disturbances, and systemic effects of cardiac and non-cardiac diseases. While echocardiography provides detailed anatomical and functional insights, ECG remains unmatched in the evaluation of cardiac rhythm abnormalities and conduction defects.

What is an Electrocardiograph, Electrocardiography, and Electrocardiogram?
Electrocardiograph: The machine/device used to record the electrical activity of the heart.

Electrocardiography: The process of obtaining the electrocardiogram.

Electrocardiogram (ECG/EKG): The graphical representation of the electrical activity of the heart, plotting depolarization and repolarization events of the atria and ventricles against time.

Historical Background
The development of ECG traces back to Harvey (1616), who described circulation, and Waller (1887), who first recorded electrical activity of the human heart. Einthoven (1895) introduced the nomenclature P, Q, R, S, and T and developed the string galvanometer, earning the Nobel Prize in 1924. Veterinary applications began in the early 20th century, with Waller (1909) recording canine heart activity and Norr (1922) using ECG clinically in dogs.

Principle of ECG

- The ECG records voltage changes generated during the depolarization and repolarization of cardiac muscle fibers.
- P wave: Atrial depolarization
- QRS complex: Ventricular depolarization
- T wave: Ventricular repolarization
- Each cardiac cycle produces a series of these waves, segments, and intervals, which reflect the electrical conduction pathway of the heart.

The Conduction System of the Heart

The canine and feline hearts, electrically, are considered in two units: atria and ventricles. The impulse originates at the sinoatrial (SA) node, travels via internodal fibers to the atrioventricular (AV) node, then passes through the bundle of His, right and left bundle branches, and Purkinje fibers to activate the ventricular myocardium.

- P wave represents atrial depolarization.
- PR interval reflects atrioventricular conduction delay.
- QRS complex shows ventricular depolarization.
- ST segment and T wave represent ventricular repolarization.

Equipment and Paper

- **Electrocardiograph machine:** Voltage meter with amplifiers and recording system.
- **Electrodes:** Standard four limb electrodes (RA, LA, RL, LL) and additional precordial (chest) leads.
- **Paper:** Graph paper with 1 mm squares; at 25 mm/s, each small square equals 0.04 sec (horizontal) and 0.1 mV (vertical).

Lead Systems

- Bipolar standard leads (I, II, III) – record potential differences between two limbs.
- Augmented unipolar leads (aVR, aVL, aVF) – compare electrical potential at one limb with the sum of the others.
- Chest leads (V leads) – provide transverse plane views (commonly V10 in dogs and cats).
- Bailey's hexaxial system – combines standard and augmented leads, most used in

small animal practice.

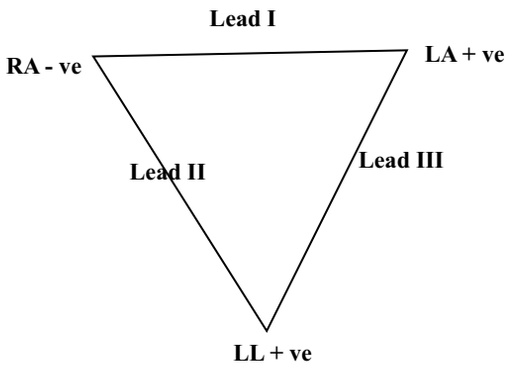

Fig.1. Diagrammatic representation of standard lead system.RA-right arm or right forelimb, LA- left arm or left forelimb, LL- left foot or left hind limb.

Recording Technique

For recording an electrocardiogram in dogs and cats, the animal is generally positioned in right lateral recumbency on a table covered with a non-conductive surface to avoid electrical interference. Electrodes are attached close to the elbows and stifles after clipping the hair if necessary, and the contact points are moistened with electrocardiographic gel or alcohol to ensure proper conduction. Most patients can be adequately restrained manually, although in nervous or uncooperative animal's mild sedation with agents such as diazepam or acepromazine may be administered without significantly altering cardiac function. The ECG is usually recorded at a paper speed of either 25 or 50 mm per second, with the sensitivity commonly set so that 10 millimeters correspond to 1 millivolt of electrical activity, which allows for accurate measurement and interpretation of the complexes.

Common Artifacts

- Artifacts may interfere with ECG interpretation:
- Electrical interference (improper grounding, fluorescent lights).
- Muscle tremor/panting/purring.
- Wandering baseline (respiration, movement).
- Electrode misplacement (may reverse polarity).

Systematic Interpretation of ECG

- Heart rate calculation (lead II is most common).
- Rhythm analysis (sinus rhythm vs. arrhythmias).

- Waveform and interval measurement (P, PR, QRS, ST, T, QT, RR).
- Mean electrical axis determination (normal canine MEA: +40° to +100°).
- Comparison with normal reference values.

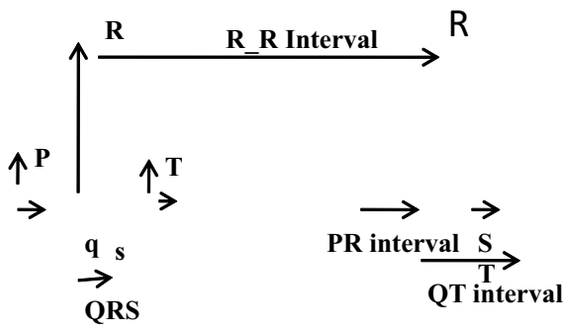

Fig.2. Measurement details of the amplitude and duration of different complexes and intervals in the electrocardiogram

Normal ECG in Dogs and Cats

Dogs:

- HR: 70–160 bpm (small breeds higher, puppies up to 220 bpm).
- P wave: 0.15–0.4 mV, 0.02–0.04 sec.
- QRS: 0.03–0.05 sec.
- T wave: 0.15–0.5 mV.
- PR interval: 0.08–0.12 sec.
- QT interval: 0.11–0.23 sec.

Cats:

- Heart Rate (HR) 140 – 220 beats/min (often higher in clinic due to stress, up to 240 bpm)
- P wave amplitude ≤ 0.2 mV
- P wave duration 0.02 – 0.04 sec
- PR interval 0.05 – 0.09 sec
- QRS duration 0.04 – 0.06 sec
- QRS amplitude (R wave) ≤ 0.9 mV (usually smaller than in dogs)
- T wave amplitude $\leq$ 0.3 mV (may be positive, negative, or biphasic; quite variable in cats)
- QT interval 0.12 – 0.18 sec (rate-dependent; shorter with tachycardia)

When to Use ECG

Electrocardiography should be considered an important diagnostic tool in both dogs and cats whenever there is a suspicion of cardiac or systemic involvement affecting the heart. It is particularly useful in patients where arrhythmias are detected during routine auscultation, as it helps to confirm the type and significance of the rhythm disturbance. Likewise, animals presenting with episodes of syncope, unexplained collapse, or seizures benefit from ECG evaluation to rule out cardiac causes. Respiratory signs such as dyspnea, persistent coughing, or the detection of heart murmurs also warrant electrocardiographic examination, since these may be secondary to underlying cardiac dysfunction. Beyond cardiopulmonary conditions, ECG has value in cases of trauma, shock, or electrocution where myocardial injury or rhythm disturbances may occur. It is equally relevant in systemic illnesses such as renal and endocrine disorders, as well as in patients with electrolyte imbalances that can alter cardiac conduction. Finally, ECG is recommended as part of routine pre-anesthetic screening to assess baseline cardiac status and minimize anesthetic risk.

Clinical Significance

Arrhythmias: ECG is the only definitive diagnostic tool.

Chamber enlargement: Tall P wave (RA enlargement), broad P wave (LA enlargement), tall R wave (LV enlargement), deep S wave (RV enlargement).

Conduction blocks: Prolonged PR interval (1st degree AV block), wide QRS complexes (bundle branch blocks).

Electrolyte disturbances: Hyperkalemia (tented T waves), hypokalemia (biphasic T waves).

Other findings: ST elevation/depression, QT interval changes.

Limitations

Although electrocardiography is a valuable diagnostic tool in small animal practice, it does have certain limitations that must be kept in mind during interpretation. It cannot provide information about structural abnormalities such as valvular disease, myocardial wall thickness, or the presence of obstructive lesions within the heart or great vessels. Furthermore, normal variations associated with breed differences and body conformation often complicate the interpretation of ECG tracings, making it difficult to establish universal reference values. Most importantly, a normal electrocardiogram does not necessarily rule out the presence of heart disease, since many structural or functional abnormalities may exist without producing detectable electrical changes on the ECG.

Conclusion

Electrocardiography is a fundamental diagnostic technique in small animal cardiology. While limited in detecting structural heart disease, it is indispensable for the evaluation of arrhythmias, conduction abnormalities, and certain systemic effects on the heart. A systematic approach to recording and interpretation, coupled with knowledge of normal canine and feline values, enhances diagnostic accuracy and guides therapeutic decisions.

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Surgical Management of Abdominal Cavity Disorders in Canines

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Gastric Foreign Body

Dogs are naturally curious and often engage in playing with and consuming non-food items, which can lead to gastric foreign body syndrome (Tripathi *et al.,* 2010). These objects are easily swallowed, becoming lodged in the stomach, and can result in complications such as ulceration, malnutrition, dehydration, and potentially death (Chiang and Chou, 2005). Common clinical signs include persistent vomiting, partial or complete anorexia, weight loss, and lethargy (Uma Rani *et al.,* 2010). Puppies are more prone to gastric foreign bodies due to their indiscriminate and excessive eating habits (Fossum, 2007). The progression and severity of the condition depend on the location of the obstruction and whether it is partial or complete.

Clinical sign:

- Vomiting
- Loss of appetite
- Abdominal pain
- Diarrhea
- Dehydration
- Lethargy

Diagnosis: Based on clinical sign and plane radiographs or contrast radiograph.
Treatment:
Endoscopic Removal: Typically, effective if the object is reachable.
Procedure: Performed under anaesthesia with an endoscope to retrieve the foreign body.
Gastrotomy: Used for larger, rough, or inaccessible objects.

Surgical technique:

The surgical site is aseptically prepared for the procedure. A midline incision is made to perform a laparotomy. The stomach is gently exteriorized through the

laparotomy opening and isolated using sterile surgical towels. The foreign body within the stomach wall is localized and enclosed within a pouch, which may be clamped distally with bowel clamps if required. An incision, either longitudinal or transverse depending on the foreign body's size is made along the pouch, taking care to preserve gastric vessels as much as possible. The foreign body is carefully removed, and any protruding mucosa at the incision site is trimmed flush with the wound edges. The incision is then closed with a layer of Cushing sutures, followed by an overlying continuous Lembert suture for reinforcement. The stomach surface is thoroughly rinsed with sterile saline before being repositioned in its normal anatomical location and the packing towels are removed. Finally, the laparotomy wound is closed in standard fashion.

Postoperative Care*:*

- Broad spectrum antibiotic for seven days
- Analgesic agent for 3 days
- Monitor for signs of infection (peritonitis), and reintroduce food slowly after 48 hours.

Gastric Bleeding

Diagnosis: Endoscopy is preferred; surgery may be necessary if other methods fail.

Treatment:

Medical Management:

- Fluid Therapy: Stabilization (e.g., Lactated Ringer's solution 5-10 mL/kg/hr IV).
- Acid Suppression: Proton pump inhibitors (e.g., Omeprazole) and H2 receptor antagonists (e.g., Ranitidine).
- Mucosal Protection: Synthetic prostaglandins (e.g., Misoprostol).

Surgical Intervention: Required for uncontrolled bleeding or perforation.

- Procedure: Inspect the stomach, remove ulcers, or perform a gastrectomy.

Postoperative Care*:*

- Broad spectrum antibiotic for seven days
- Analgesic agent for 3 days
- Monitor for signs of infection (peritonitis), and reintroduce food slowly after 48 hours.

Gastric Dilatation and Volvulus (GDV)

Gastric dilatation and volvulus (GDV) is a life threatening condition, characterized

by abnormal gastric distension with gastric gasses and its rotation along its mesenteric axis (Bhatia *et al.,* 2010). This condition can occur in many species including man, but more frequent in dogs (Glickman *et al.,* 2000). Vascular compromise resulting in gastric necrosis followed by shock and death may occur in this condition (Guilford, 1996).The mortality of GDV is reported up to 68% in earlier studies (Mackenzie *et al.,* 2010), where as in recent reports up to 26.8% (Green *et al.,* 2011).

Clinical Signs

- Restlessness or pacing
- Nonproductive vomiting or retching
- Excessive salivation (ptyalism)
- Abdominal distension
- Weakness
- Collapse in severe cases

Diagnosis

Clinical Sign and abdominal radiography, particularly the right lateral projection, is diagnostic for GDV

Management:

- Supportive care for patient stabilization
- Surgical correction

After induction of general anaesthesia, the dog is positioned in dorsal recumbency, and the abdomen is aseptically prepared for surgery. A cranial midventral laparotomy is performed to access the stomach. Gastric decompression is most commonly achieved via gastrotomy but can also be accomplished by passage of an orogastric tube. Once decompressed, the stomach and spleen are carefully examined for signs of ischemia. Devitalized portions of the gastric wall are resected, and splenectomy is performed if splenic vascular compromise is present. Extensive gastric necrosis, particularly involving the cardia, is associated with a poor prognosis. Anatomical repositioning of the stomach is essential to prevent recurrence of gastric dilatation–volvulus (GDV). In some cases, spontaneous repositioning may occur following decompression. To minimize the risk of recurrence, a gastropexy is performed, most commonly using either the Belt-Loop or Circumcostal technique.

Belt-Loop Gastropexy

This method involves creating a seromuscular antral flap anchored around a segment of transversus abdominis muscle.

- A horseshoe-shaped incision is made in the serosal layer of the gastric antrum, based at the greater curvature.
- The seromuscular layer is isolated by gently separating the mucosa from the full-thickness wall using thumb and index finger, then incised with scissors.
- The antral flap is dissected free of submucosa, the stomach returned to its normal position, and the flap aligned with the transversus abdominis.
- Two longitudinal incisions are made in the transversus muscle fibers, and the intervening muscle segment undermined.
- The gastric flap ("belt") is passed through the transversus muscle tunnel ("loop") and sutured to itself with 2-0 monofilament absorbable sutures in a simple interrupted pattern.

Circumcostal Gastropexy

- Place stay sutures approximately 4 cm apart on the ventral pyloric antrum.
- Create an "I"-shaped seromuscular incision, about two-thirds the length of the antrum, parallel to its long axis.
- Elevate two seromuscular flaps (3 cm × 1–1.5 cm) without penetrating submucosa or mucosa.
- Expose one of the last four right costal arches by sharply incising and reflecting muscle over ~5 cm at the costochondral junction.

Caution: The diaphragm is close; avoid pneumothorax.

- Pass the flap around the exposed costal arch and suture to the opposing flap using simple interrupted 2-0 synthetic absorbable sutures.

Postoperative Management

- Withhold food and water for 48 hours after surgery; maintain hydration using polyionic isotonic crystalloid fluids at 60 mL/kg/day.
- If vomiting persists, continue withholding oral intake and adjust fluid therapy accordingly.
- After 24 hours without vomiting, reintroduce food gradually over 2–3 days, starting with a liquid diet, progressing to soft/baby food, and finally returning to the regular diet.
- Continue antibiotic therapy for 7–10 days postoperatively.
- Provide analgesic therapy for a minimum of three days.

Intestinal obstruction:

Intestinal obstruction occurs when the movement of intestinal contents is blocked, preventing them from progressing further through the intestine. In dogs and cats, one of the primary causes of obstruction is the presence of foreign bodies in the intestines. The obstruction can be either partial or complete, depending on the size of the foreign object (Papazoglou*et al.,* 2003). In small animal, intestinal obstruction, presenting with a range of clinical signs that vary based on the location, severity, and duration of the obstruction (Aronson et al., 2000; Papazoglou et al., 2003). Gastrointestinal obstruction leads to disruptions in fluid balance, acid-base levels, and serum electrolyte concentrations due to hypersecretion and fluid sequestration in the gastrointestinal tract. These disturbances are worsened by vomiting and reduced fluid and nutrient intake (Boag*et al.,* 2005). Ingestion is considered the primary method through which foreign bodies enter the intestines of small animals (Hunt et al., 2004). Diagnosis is made through clinical signs, radiography, and ultrasonography.

Clinical sign:

- Vomiting
- Gagging or retching
- Lethargy
- Drooling
- Loss of appetite
- Diarrhea
- Straining to poop
- Restlessness
- Painful abdomen
- Prayer position
- Bloating

Diagnosis is made through clinical signs, radiography, and ultrasonography.

Treatments:

Stabilization

Before any specific treatment, stabilizing the dog is essential.

- **Intravenous fluids**: To correct dehydration, electrolyte imbalances, and acid-base disturbances.
- **Pain management**: Analgesics may be administered to manage discomfort.
- **Anti-emetics**: Medications to control vomiting.

Surgical Treatment

Enterotomy:

Perform laparotomy at the mid ventral or chosen site. The laparotomy wound is retracted and intestinal coils are examined to locate the foreign body by drawing the coils between the fingers. the affected segment of intestine is exteriorized and isolated by packing with surgical towels and is clamped before and behind with bowel clamps. A full thickness longitudinal incision is made on the free (anti-mesenteric) border in healthy tissue proximal to the obstruction. the obstruction is removed and the opening is closed by Cushing's sutures or by continuous Lembert's sutures. Size 3/0 medium chromic catgut with atraumatic needle is suitable for intestinal sutures. the towels are removed after cleaning the bowel surface with saline solution. the laparotomy wound is closed after returning the bowel into abdominal cavity.

Resection and Anastomosis:

In severe cases where part of the intestine is damaged or necrotic, that portion may need to be removed. The healthy ends of the intestine are then reconnected (anastomosis).

Intussusception in Dogs

It is a condition where a segment of the intestine telescopes into an adjacent section, leading to intestinal obstruction. It is one of the common cause of mechanical obstruction of intestine in dogs (Singh *et al.,* 2015). Puppies and kittens have a significantly higher incidence of intussusception compared to adult animals (Applewhite *et al.,* 2002; Atray*et al.,* 2012; Ghashghaii*et al.,* 2017). Intussusceptions in young animals are considered idiopathic, however various predisposing factors may contribute to its occurrence. These factors include intestinal parasitism, linear foreign bodies (such as bones and plastic toys), parvoviral enteritis leading to intestinal hypo- or hypermotility, non-specific gastroenteritis, intraluminal masses, prior abdominal surgery, hypertrophied lymphoid nodules, and granulomatosis resulting from inflammatory conditions (Guilford and Strombeck, 1996; Rallis et al., 2000; Rewerts and Cohn, 2000; Patsikas*et al.,* 2003, 2008; Schwandt, 2008; Allenspach, 2010; Gelberg, 2012). If intussusception remain prolonged, the trapped tissue can become ischemic, devitalized and necrosed. Therefore, it is a medical emergency that requires prompt diagnosis and treatment.

Clinical Signs:

- Persistent or recurring vomiting
- Diarrhea (often with blood)
- Abdominal pain (e.g., whining, stretching, guarding)
- Lethargy and weakness
- Weight loss in chronic cases
- Dehydration

Diagnosis:

Physical Exam: Abdominal palpation may reveal a mass, suggesting obstruction.

Ultrasound: The most effective diagnostic tool, revealing the characteristic telescoping of the intestine.

Radiographs: May show site of obstruction but are less specific.

Contrast Studies: Sometimes used if ultrasound results are inconclusive.

Treatment:

Emergency Surgery:

Procedure: A laparotomy is performed to locate and manually reduce the intussusception. If the affected part of the intestine is non-viable (due to necrosis), it may require resection and anastomosis (removal of the damaged part and reconnection of healthy ends).

Gastropexy: In some cases, part of the intestine may be anchored to prevent recurrence.

Postoperative Care:

- Fluid therapy
- Antibiotic and analgesic agent.

Blood Transfusion in Veterinary Practice: A Comparative Overview for Ruminants and Companion Animals

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Blood transfusion is a critical therapeutic intervention in both large and small animal veterinary practice. It involves the administration of whole blood or blood components from a donor to a recipient animal to restore circulatory volume, improve oxygen-carrying capacity, or correct coagulation abnormalities. The application of transfusion has expanded with better understanding of species-specific blood types, transfusion techniques, and blood component therapies. In ruminants such as cattle, sheep, and goats, transfusions are mainly used in acute hemorrhage or parasitic anemia, while in companion animals like dogs and cats, the indications are more diverse and frequently encountered in clinical practice.

Blood Groups in Animals

Each species has distinct blood group systems which are crucial in avoiding transfusion reactions. Cattle have 11 blood group systems with complex polymorphisms; the B system is highly antigenic. Sheep and goats also have several group systems, though their clinical relevance is less defined. Dogs have more than a dozen blood group systems, most notably the Dog Erythrocyte Antigen (DEA) system, where DEA 1.1 is most significant for transfusion compatibility. Cats have three blood types: A, B, and AB. Naturally occurring alloantibodies in cats mean that unmatched transfusions can be fatal, making typing essential even before the first transfusion.

Indications for Transfusion

Blood transfusions are indicated in a variety of clinical conditions. In cattle, sheep, and goats, the primary indications include acute blood loss due to trauma or surgery, parasitic anemia (e.g., Haemonchosis), and coagulopathies. In small animals, indications extend to immune-mediated hemolytic anemia (IMHA), rodenticide poisoning, thrombocytopenia, disseminated intravascular coagulation (DIC), and hypoalbuminemia. Fresh whole blood, packed red blood cells (pRBCs), plasma, and platelet-rich plasma are used according to the specific need of the patient.

Materials Required

Blood transfusion requires appropriate materials for safe collection, storage, and administration:

- Blood bags with anticoagulants (e.g., CPDA)
- Blood administration sets with filters (BT set)
- Sterile syringes and needles
- Centrifuge for component separation
- Cross-matching and typing kits
- Refrigerators and freezers for storage

Donor and Recipient Selection

Ideal donors are healthy, adequately vaccinated, and free of infectious diseases. In cattle and small ruminants, herd members are usually selected. A bovine donor can safely give up to 10–15 mL/kg body weight. Dogs weighing over 25 kg and cats over 4.5 kg are typically used as donors. Donors must be screened for diseases like Babesiosis, Anaplasmosis, Ehrlichiosis in dogs, and FeLV/FIV in cats. Recipients must be clinically evaluated for the need based on PCV, clinical signs, and hemodynamic parameters.

Compatibility Testing

Cross-matching is a laboratory procedure performed before blood transfusion to ensure compatibility between donor and recipient animals. It is aimed at preventing potentially fatal **immunologic transfusion reactions** due to blood group incompatibilities. Cross-matching detects the presence of naturally occurring or acquired antibodies that may cause **hemolysis**or **agglutination**of red blood cells (RBCs).

Types of Cross-Match

1. **Major Cross-Match**:
   - Tests **recipient's serum** (antibodies) against **donor's RBCs.**
   - Critical for detecting antibodies in the recipient that may attack donor RBCs.
   - **Essential in all species,** especially cats and previously transfused dogs.
2. **Minor Cross-Match**:
   - Tests **donor's serum**against **recipient's RBCs.**
   - Detects antibodies in donor plasma that might react with the recipient's RBCs.
   - Less critical in dogs, where donor plasma is often diluted or removed (packed RBCs used).

Materials Required

- Fresh blood samples from **donor**and**recipient:**
  - **EDTA tube** (for RBCs)
  - **Plain tube** (for serum)
- Centrifuge
- Microscope slides and cover slips
- Normal saline (0.9% NaCl)
- Test tubes (preferably labeled)
- Water bath (37°C)
- Light microscope
- Pipettes or droppers

Step-by-Step Cross-Matching Procedure

1. Sample Preparation

- Collect **2–3 mL**of blood from both donor and recipient:
  - Separate **serum** by centrifuging clotted samples at 1500 rpm for 10 minutes.
  - Wash RBCs from EDTA blood 3–4 times in **normal saline** by centrifugation (1500 rpm for 2–3 minutes).
  - After final wash, make a **2–5% RBC suspension** in saline.

2. Major Cross-Match

- Mix:
  - **2 drops of recipient serum**
  - with **1 drop of donor RBC suspension**
- Incubate at 37°C for 15–30 minutes.
- Examine:
  - **Macroscopically** for hemolysis or agglutination.
  - **Microscopically** under 10x or 40x for RBC clumping (agglutination).

3. Minor Cross-Match

- Mix:
  - **2 drops of donor serum**
  - with **1 drop of recipient RBC suspension**
- Follow same incubation and examination steps.

4. Control Tubes (Optional but Recommended)

- To validate results and rule out nonspecific reactions:

- **Auto-control:** Mix recipient serum with recipient RBCs.
- **Saline control:** Mix saline with RBC suspension (ensures no spontaneous agglutination).

Interpretation of Results

Finding	Interpretation	Action
No hemolysis or agglutination	Compatible	Safe to transfuse
Hemolysis or agglutination in major	Incompatible	Do **not** use donor

Important Species-Specific Notes

- **Cats**: Have naturally occurring alloantibodies. Cross-match always, even for the first transfusion.
- **Dogs**: First transfusion may be safe without cross-match, but must cross-match for subsequent transfusions or unknown history.
- **Ruminants**: May tolerate first mismatched transfusion; however, cross-matching is ideal, especially for valuable animals or repeat transfusions.

Procedure of Blood Collection and Transfusion

Blood is collected aseptically from the jugular vein using anticoagulant-containing bags. It should be gently agitated during collection. For transfusion, blood is warmed to room temperature and administered intravenously via a filter. The rate starts at 0.5–1 mL/kg/hr for the first 15 minutes to monitor for reactions, then increased up to 10 mL/kg/hr. Total transfusion volume should not exceed 20 mL/kg per session and be completed within four hours.

Benefits of Transfusion

Transfusion provides immediate physiological benefits:

- Restores oxygen-carrying capacity (RBCs)
- Replenishes clotting factors (plasma)
- Corrects thrombocytopenia (PRP)
- Maintains oncotic pressure (albumin)

In ruminants, it significantly improves survival in periparturient hemorrhage and parasitic anemia. In small animals, targeted component therapy reduces the risk of volume overload and improves clinical outcomes in IMHA, DIC, and surgical interventions.

Adverse Reactions and Their Management

Adverse transfusion reactions include:

- Hemolytic reactions: due to mismatched blood
- Febrile non-hemolytic reactions
- Allergic reactions: urticaria, vomiting
- Anaphylaxis
- Infectious disease transmission
- Hypocalcemia due to citrate toxicity

To avoid these, use typed and cross-matched blood, start transfusions slowly, monitor continuously, and use appropriate filters. Corticosteroids or antihistamines may be pre-administered in at-risk patients.

Important Points to be remember for whole blood transfusion in cattle		
S.No.	**Parameter**	**Value**
1.	Critical anemia (PCV)	12%
2.	Circulating blood volume (CBV)	8% of body weight (kg)
3.	Donor collection volume	10–15 mL/kg or 20% of CBV
4.	Initial administration rate	1–5 mL/kg/h for first 10–20 min
5.	Rate of administration	10–20 mL/kg/h
6.	Emergency drugs	Flunixinmeglumine (pre-med) 1.1 mg/kg, IV Epinephrine 0.002–0.003 mg/kg, IV

Conclusion

Blood transfusion and component therapy are vital tools in veterinary care for both food-producing and companion animals. The success of transfusion depends on species-specific knowledge, appropriate donor and recipient selection, and careful monitoring. With advancements in transfusion medicine and better access to diagnostic tools, veterinarians can save lives with safer and more effective transfusion protocols.

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नामांकन नोटिस

बिहार पशु विज्ञान विश्वविद्यालय, पटना के अधीन बिहार पशु चिकित्सा महाविद्यालय,पटना एवं संजय गाँधी गव्य प्रौद्योगिकी संस्थान, पटना में शैक्षणिक सत्र 2025–2026 में नये पाठ्यक्रम शुरू किए जा रहा है, नामांकन हेतु विवरणी निम्नवत् है:–

बिहार पशु चिकित्सा महाविद्यालय, पटना

कोर्स का नाम	अवधि
बी.एस.सी. (पोल्ट्री प्रोडक्शन)	3 वर्ष (6 सेमेस्टर)

पैरा वेटरनरी साइंसेज

कोर्स का नाम	अवधि
डिप्लोमा इन वेटरनरी एंड लाइवस्टॉक डेवलपमेंट (डी.वी.एल.डी.)	2 वर्ष (4 सेमेस्टर)
डिप्लोमा इन वेटरनरी लेबोरेटरी टेक्नोलॉजी (डी. वी. एल. टी.)	2 वर्ष (4 सेमेस्टर)
सर्टिफिकेट कोर्स इन आर्टिफिशियल इन्सेमिनेशन	3 माह

पोस्ट ग्रेजुएट डिप्लोमा

ऑनलाईन – वेटरनरी होम्योपैथी, एथ्नोवेटरनरी मेडिसिन, वन हेल्थ, ऑफलाईन – बोवाइन क्लिनिकल प्रैक्टिस, कैनाइन एंड फेलाइन क्लिनिकल प्रैक्टिस ।
एडवांस ट्रेनिंग कोर्स ऑन इम्पोर्टेंट वेटरनरी क्लिनिकल प्रोसीजर अवधि: 3 सप्ताह, प्रवेश क्षमता: 6

सर्टिफिकेट कोर्स

वेटरनरी फॉरेंसिक साइंस, सीमन हैंडलिंग एवं आर्टिफिशियल इन्सेमिनेशन, मॉलिक्यूलर डायग्नोसिस ऑफ इन्फेक्शस डिजीजेस, वेटरनरी डायग्नॉस्टिक इमेजिंग, एम्ब्रायो ट्रांसफर टेक्नोलॉजी (आईवीएफ) इन बोवाइन।

ऑनलाइन पाठ्यक्रम

फीड एवं फॉडर टेक्नोलॉजी पर ऑनलाइन शार्ट कोर्स
प्रसार एवं उद्यमिता विकास पर ऑनलाइन शार्ट कोर्स

संजय गाँधी गव्य प्रौद्योगिकी संस्थान, पटना

कोर्स का नाम	अवधि
बी.टेक. (एफ.टी.)	4 वर्ष (8 सेमेस्टर)

प्रवेश क्षमता, अवधि एवं सभी कोर्स की विस्तृत जानकारी हेतु विश्वविद्यालय की वेबसाइट www. basu.org.in पर अपलोड किए गए विवरण पुस्तिका को देखें।

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