BVSC & AH STUDY BOOK 4 OF 7

Applied and Supportive Therapeutics

Seven chapters on the drugs and supportive care used every day in practice: skin, eye and ear products, vitamins and minerals, fluids, herbal medicines, feed additives, and medicines for poultry and fish. Each chapter ends with a 10-question self-test.

7 chapters | **70** practice questions | **No** dose tables

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Start here

Pick a chapter from the list on the left (or the top bar on a phone). The chapters are practical: they turn the science of Books 1 to 3 into everyday decisions about skin, eye and ear products, nutrition, fluids, herbal and ethnoveterinary remedies, feed additives and flock or pond medication. Each chapter has six parts: Learn, Concepts, Compare, Species, Quiz and Revise. Your quiz progress is saved on this device only.

CHAPTER 1 OF 7

Dermatological drugs

How skin drugs are chosen and used: vehicles and topical principles, medicated shampoos, antiseptic and antifungal products, antipruritics and the drugs used in atopic dermatitis. The emphasis is on safety, species cautions and what to tell the owner.

After this chapter you can

- Explain how the vehicle and contact time influence the result of a topical skin product

- Describe the action and main cautions of common shampoo and antiseptic ingredients
- Compare the antipruritic drug groups by mechanism, speed of action and safety concerns
- Outline a multimodal approach to canine atopic dermatitis and why pruritus control alone is not enough
- Counsel an owner or farmer on safe use of skin products, including species cautions and residue concerns

Principles of topical skin therapy

Skin is both a barrier and a route. A topical product must reach the layer where the problem lives: surface, hair follicle, stratum corneum or deeper dermis. Most topical drugs act on the surface and follicle only, so they suit superficial disease and do little for deep infection.

The **vehicle** matters as much as the drug. Solutions, lotions and sprays spread easily over haired skin. Creams are water-based and good for moist or inflamed areas. Ointments are greasy, occlusive and soften crusts, but they trap heat and are poorly suited to wet skin. Gels and spot-on products are convenient for dogs and cats.

Three practical points follow. First, **contact time** decides how much drug works, so the label instructions for how long a shampoo stays on the coat should be followed. Second, animals **lick**, so every topical drug is also an oral exposure, which is serious in cats because of grooming. Third, **the person applying the product** needs gloves, since many ingredients irritate human skin.

Medicated shampoos

Shampoo therapy treats the whole body, removes scale, crust and allergens, and delivers an active ingredient in one step. The ingredient is chosen by the skin problem.

- **Chlorhexidine**: a broad antibacterial and some antifungal action, with good residual effect on the skin. Mostly well tolerated, but it can dry the skin and should be kept out of the eyes and ears.

- **Benzoyl peroxide**: antibacterial and follicular flushing, useful in greasy skin and deep follicular disease. It can dry and irritate, and it bleaches fabric and coloured coats.
- **Sulfur and salicylic acid**: keratolytic and keratoplastic, so they loosen scale and normalise keratinisation in seborrhoeic conditions. They can dry the skin.
- **Coal tar**: slows cell turnover in seborrhoea but is smelly, staining and irritant. Many references advise avoiding it in cats.
- **Colloidal oatmeal, lipids and ceramide products**: soothe and support the barrier, so they suit dry or allergic skin and frequent bathing.

A common confusion is that stronger means better. Frequent use of drying shampoos damages the barrier and worsens itch, so a moisturiser or conditioner is often added.

Antiseptic and antifungal skin products

Antiseptics kill or inhibit microbes on living tissue without being absorbed in large amounts. Because they act through several mechanisms, resistance is less of a problem than with antibiotics, which is why topical antiseptic therapy is encouraged for **superficial pyoderma** in line with antimicrobial stewardship.

Chlorhexidine is the standard skin antiseptic. **Povidone-iodine** is broad and cheap, but it stains and can irritate, and iodine absorption is a theoretical concern with large-area or repeated use. Alcohol-based products sting on broken skin.

For dermatophytosis (ringworm), topical **azoles** such as miconazole or enilconazole where available, and lime sulphur dips, reduce spore load on the coat. Lime sulphur smells strongly, stains jewellery and can be licked off by cats, so a collar is advised. Topical therapy alone seldom cures ringworm, as the infection sits in the hair shaft, so systemic therapy and environmental decontamination are usually combined. Infected hairs and contaminated bedding keep reinfecting the animal.

Topical antibiotics that are important in human medicine should be reserved; *check the current guidance and notifications on antimicrobial use* before choosing them for animals.

Antipruritics

Itch is a symptom, not a diagnosis. The first step is to find and treat the cause: fleas, scabies, infection, yeast, food reaction or atopy. Antipruritic drugs then reduce suffering while the cause is managed.

- **Glucocorticoids** are fast and effective. They suppress inflammation broadly, but with long systemic use they cause polyuria, polydipsia, appetite change, infection risk and suppression of the adrenal axis. Topical steroids can thin the skin. Newer topical forms were designed to act locally with less systemic effect.
- **Oclacitinib** blocks Janus kinase enzymes (mainly JAK1) and so reduces signalling by itch-related cytokines such as IL-31. It acts within a day, but it can mask or worsen infection and demodicosis, and the label restricts use in young dogs. Check the product label and availability in India.
- **Lokivetmab** is a monoclonal antibody that neutralises IL-31. It is not immunosuppressive and is eliminated without liver or kidney metabolism, but it is given by injection at a clinic and the effect is dog-specific.
- **Ciclosporin** inhibits T-cell activation through calcineurin. It is slow, taking weeks, and the main side effect is vomiting.
- **Antihistamines** help few dogs with atopic itch and are mostly useful in combination, with sedation as a side effect.
- **Essential fatty acids** are supportive and slow.

Atopic dermatitis: a multimodal plan

Canine atopic dermatitis is a genetically predisposed, chronic inflammatory and itchy skin disease linked to a defective barrier and an exaggerated immune response to environmental allergens. It is a **diagnosis of exclusion**, since parasites, infection and cutaneous adverse food reaction must be ruled out. A strict, properly conducted food trial is the only reliable test for food allergy.

Treatment stands on several legs, because no single drug controls everything.

1. Control fleas and other parasites strictly.
2. Treat secondary bacterial and *Malassezia* infections, ideally with topical products.
3. Repair and protect the barrier with bathing, moisturisers and fatty acids.
4. Control itch with one of the antipruritics above, chosen for speed, safety and cost.

5. Consider **allergen-specific immunotherapy** after allergy testing, which is the only treatment that changes the immune response. It works slowly and not in every dog.

Two common confusions: starting steroids before the work-up masks the diagnosis, and stopping the drug as soon as the itch settles invites a flare. Owners need to understand that atopy is managed, not cured.

Safety, species cautions and the owner or farmer

Cats are the main species at risk. They groom, they have limited glucuronidation, and many products safe in dogs are toxic to them. Avoid tea tree and other essential oils, and avoid high-concentration phenolic and salicylate products. Do not use a dog product in a cat unless the label says it is allowed.

Always check that the product is for the correct species, and warn owners not to mix products. Keep treated animals from licking each other. Use an Elizabethan collar or let the coat dry before contact with children.

For **food animals**, skin products can be absorbed, especially across inflamed skin or when used as dips and pour-ons. Residues may reach milk, meat or eggs. The farmer should observe the label **withdrawal period** and keep treatment records, and the vet should check the current notification on residue limits for India rather than relying on memory. Do not use products intended for pets on dairy animals.

Finally, tell the owner what success looks like, how long treatment will last, and which signs, such as spreading redness, pus or sudden worsening, mean they must return.

Concept cleared

Vehicle decides delivery
The same drug in a shampoo, cream or ointment behaves differently. Choose the vehicle for the lesion, the haircoat and the animal's grooming habits.

Antiseptics first for superficial infection

Topical antiseptics reduce the need for systemic antibiotics in superficial pyoderma, supporting stewardship and lowering resistance pressure.

Itch is a symptom

Antipruritics treat suffering, not the cause. Parasites, infection and food reactions must be investigated, or the itch returns.

Drug classes differ in speed and safety

Steroids and oclacitinib act quickly, ciclosporin needs weeks, lokivetmab avoids immunosuppression. Match the drug to the patient's needs and risks.

Memory aid: VICE for a topical plan

Vehicle, Infection control, Contact time, Ensure species safety. Check each before dispensing any skin product.

Compare and contrast

Common medicated shampoo ingredients

Ingredient	Main action	Best use	Key caution
Chlorhexidine	Antibacterial, some antifungal	Superficial pyoderma, yeast	Drying, avoid eyes and ears
Benzoyl peroxide	Antibacterial, degreasing, follicular flushing	Greasy skin, follicular disease	Drying, bleaches fabric
Sulfur and salicylic acid	Keratolytic, keratoplastic	Scaling, seborrhoea	Drying
Coal tar	Slows cell turnover	Seborrhoea in dogs	Odour, staining, avoid in cats
Colloidal oatmeal and lipids	Soothing, barrier support	Dry or allergic skin	Few; may not control infection

Antipruritic drug groups in the dog

Drug	Mechanism	Onset	Main caution
Glucocorticoid	Broad anti-inflammatory	Fast	Systemic and skin side effects with long use
Oclacitinib	JAK inhibitor, blocks IL-31 signal	Within a day	Infection, demodicosis, age limits on label
Lokivetmab	Anti-IL-31 antibody	Fast	Injection, species specific, cost
Ciclosporin	Calcineurin inhibitor, T cells	Weeks	Vomiting, slow onset
Antihistamine	H1 blockade	Fast	Limited benefit, sedation

Species notes

Dog

Most skin products are designed for dogs. Frequent bathing with drying shampoos needs a moisturiser, and atopic dogs need a long-term multimodal plan.

Cat

Grooming makes ingestion likely. Avoid essential oils, tar shampoos and any non-feline product, and use a collar after lime sulphur or similar products.

Horse

Topical antifungals and shampoos are widely used for rain scald, ringworm and sweet itch. Wear gloves, as ringworm spreads to people, and disinfect tack and brushes.

Cattle and small ruminants

Ringworm and ectoparasite treatments may be sprays or dips. Residues in milk and meat matter, so check the label withdrawal period and local notifications.

Rabbits and small mammals

Skin is thin and grooming is constant. Use only products labelled or advised for the species, and avoid wetting the animal heavily.

Clinical pearls

Self-test: 10 questions

1. Which statement about the vehicle of a topical drug is correct?

The vehicle influences how the drug spreads and is retained. Ointments are occlusive and unsuited to wet skin.

2. Why is licking a particular concern after applying a topical product to a cat?

Cats groom extensively and have limited glucuronidation, so oral exposure can cause toxicity.

3. Which shampoo ingredient is keratolytic and keratoplastic?

Sulfur and salicylic acid loosen scale and normalise keratinisation.

4. A tar shampoo is generally avoided in which species?

Cats groom and are sensitive to tar products, so most references advise avoiding them.

5. Which approach best fits the principle of antimicrobial stewardship in superficial pyoderma?

Topical antiseptics treat superficial infection locally and reduce systemic antibiotic use.

6. Why does topical therapy alone often fail in ringworm?

The infection lies in the hair and spores contaminate surroundings, so systemic and environmental measures are added.

7. Which drug neutralises IL-31 without being immunosuppressive?

Lokivetmab is a monoclonal antibody against IL-31. Oclacitinib blocks JAK signalling and does suppress some immune pathways.

8. Which antipruritic usually needs weeks to show full effect?

Ciclosporin acts on T-cell activation and has a slow onset.

9. What is the only reliable test for cutaneous adverse food reaction?

Serum and skin tests are unreliable for food allergy, so a controlled diet trial is used.

10. What should a farmer observe when a skin product is used on a dairy animal?

Skin products can be absorbed, so residues may reach milk or meat. Check the label and current notification.

Key points to revise

1. Vehicle, contact time and licking decide the real exposure from a topical product.
2. Shampoo ingredients are chosen by the skin problem and can dry the skin if overused.
3. Chlorhexidine is the standard antiseptic and supports stewardship in superficial pyoderma.
4. Ringworm needs topical, systemic and environmental measures together.
5. Itch must be investigated before antipruritics are started.
6. Glucocorticoids, oclacitinib, lokivetmab and ciclosporin differ in speed, safety and cost.
7. Atopic dermatitis is controlled, not cured, and needs a multimodal plan including parasite control.

8. Cats and food animals need special caution: toxicity in cats, residues and withdrawal in food animals.

Go deeper on this site

- Ch 2. Ophthalmic and otic drugs (in this book)
- Ch 3. Vitamins and minerals in therapy (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Index
- Veterinary Drug Concepts Clearly Explained

Sources

- Merck Veterinary Manual, Integumentary System
- Merck Veterinary Manual, Pharmacology
- WSAVA Global Guidelines

CHAPTER 2 OF 7

Ophthalmic and otic drugs

How eye and ear drugs are delivered and why the route is limiting, with the main groups: ocular antimicrobials and anti-inflammatories, mydriatics, glaucoma drugs, ear cleaners and otic antimicrobials. The focus is on cautions that prevent blindness, deafness and treatment failure.

> ### After this chapter you can
>
> - Explain why topical ocular drug delivery is inefficient and how ointments, drops and the order of application affect it
> - Describe the actions and cautions of mydriatics and cycloplegics, including atropine and tropicamide
> - Explain the main glaucoma drug groups by how they lower intraocular pressure
> - Describe the role of ear cleaners and the reasons otic drugs can be ototoxic
> - Counsel owners and farmers on safe eye and ear treatment and species cautions

Eye drops and ointments: delivery

The eye is a poor place for drugs to stay. Tears wash away drops quickly, blinking drains fluid through the nasolacrimal duct, and the cornea is a barrier with both fat-loving and water-loving layers. Only a small part of a drop enters the eye. The rest drains into the nose and throat and is absorbed there, which is how topical eye drugs can have **systemic effects**.

Drops are clear, easy to see through and do not blur vision, but they must be given often. **Ointments** stay longer and can be given less often, but they blur vision, can delay the effect of other drops, and should be avoided where the globe may be perforated. **Suspensions** must be shaken so the drug is evenly mixed.

When more than one drop is given, wait a few minutes between them so the second does not wash out the first, and give ointment last. Lesions should be examined with **fluorescein stain** before any steroid is considered. Preservatives such as benzalkonium chloride can themselves irritate the surface after long use.

Antimicrobial and anti-inflammatory eye drugs

Topical antibiotics are the commonest eye drugs and are used for conjunctivitis and corneal ulcers. They do not penetrate the eye well, so a deep infection needs a different approach. In a corneal ulcer the infection and the enzymes released by tissue and bacteria can dissolve the cornea quickly, so frequent re-examination matters more than the choice of brand. Antivirals are used mainly for feline herpesvirus keratitis. Antifungals are important in horses, where fungal keratitis is common after trauma.

Two anti-inflammatory groups are used. **Corticosteroids** are powerful, but they delay healing and weaken the cornea. They are **contraindicated in an ulcerated cornea**. This is the most important single rule in veterinary ophthalmology. **Topical NSAIDs** give less anti-inflammatory power with less risk, but they also slow healing and have been linked to corneal melting in some ulcers, so they too should be used with care.

Immunomodulators such as ciclosporin or tacrolimus drops are used in keratoconjunctivitis sicca, the dry eye of dogs caused by immune destruction of the tear gland. They stimulate tear production and reduce inflammation, work over weeks and usually need long-term use.

Mydriatics and cycloplegics

Mydriatics widen the pupil. **Cycloplegics** paralyse the ciliary muscle, which relieves the painful spasm of uveitis. Both groups are mainly muscarinic antagonists.

Atropine acts for days. It is used to relieve pain in uveitis and deep ulcers, and to stop the iris sticking to the lens (posterior synechiae). Because some drug drains through the nasolacrimal duct into the mouth, it tastes bitter and cats and dogs may salivate heavily. In horses, repeated use can reduce gut motility and has been associated with colic, so the animal needs observation. It also raises intraocular pressure, so it is **contraindicated in glaucoma** and should be used carefully in animals predisposed to it.

Tropicamide acts for hours and is mainly used to dilate the pupil to examine the lens and the back of the eye. It is a diagnostic drug, not a treatment for uveitis.

A common confusion is thinking a large pupil in a painful eye means improvement. The pupil that stays dilated after atropine is expected, and the animal will be sensitive to bright light for days, so keep it out of the sun.

Glaucoma drugs

Glaucoma is raised intraocular pressure that damages the optic nerve and retina. It is an **emergency**, because vision can be lost within hours in acute cases. Pressure depends on a balance between aqueous humour made by the ciliary body and aqueous humour leaving through the drainage angle. Drugs either reduce production or increase outflow.

- **Carbonic anhydrase inhibitors** such as dorzolamide, used as drops, reduce aqueous production. Oral forms exist but have more systemic effects, including acid-base disturbance and electrolyte changes.
- **Prostaglandin analogues** such as latanoprost increase outflow and constrict the pupil. They work well in dogs, but should not be used when uveitis or anterior lens luxation is present, since they can worsen both. They are less dependable in cats and horses.
- **Beta-blockers** such as timolol reduce aqueous production. Enough may be absorbed to slow the heart or affect the airways, so cats with respiratory or cardiac disease need care.

- **Osmotic agents** such as mannitol pull water from the eye. They are used in an emergency, require hydration and cardiac assessment, and give only short-term benefit.

Long-term control also needs a plan for the other eye, as primary glaucoma is often bilateral.

Ear cleaners and otic antimicrobials

Otitis externa is rarely a single disease. Think of **predisposing** factors (conformation, moisture), **primary** causes (allergy, parasites, foreign bodies), **secondary** infection and **perpetuating** changes such as swollen or narrowed canals. Drugs deal mostly with infection, so unless the primary cause is addressed the ear flares again.

Cleaners remove wax, pus and debris that block drug contact and feed microbes. **Ceruminolytics** soften wax. **Astringent and acidifying** cleaners dry the canal and make it less friendly to microbes. Cleaners with a high dose of detergent or alcohol irritate inflamed skin. A cotton bud pushes debris deeper and is not advised.

Otic medications are commonly combinations of an antibacterial, an antifungal and a corticosteroid. The steroid reduces swelling and pain, which opens the canal. Culture and cytology guide the choice, particularly where rods such as *Pseudomonas* are present and repeated treatments have failed.

The great caution is the **eardrum**. If the tympanic membrane is ruptured, some drugs reach the middle and inner ear and can cause deafness or vestibular signs. Aminoglycosides and chlorhexidine are examples of drugs considered ototoxic in this setting. Check the tympanum, and check the product label, before use.

Cautions and counselling

For both eye and ear drugs, owners fail most often at the stage of giving the drug. Show them how, using a clean hand, a bottle that does not touch the eye or ear, and a calm restraint. Tell them how many days to continue and not to stop when the eye looks better.

Warn against **human eye or ear drops** kept at home. Some contain steroids that would be harmful for an ulcerated cornea. A red, painful, squinting eye or a head-tilting animal needs examination, not repeated home drops.

Opened bottles can become contaminated and should be discarded after the period on the label. Do not share bottles between animals. A collar prevents rubbing.

In **food animals**, infectious bovine keratoconjunctivitis (pinkeye) is a common eye problem. Eye products applied or injected in cattle must still respect the label withdrawal times for milk and meat, so a farmer should keep treatment records. Check the current Indian notification on residues rather than guessing.

Concept cleared

The eye is hard to medicate
Tears, blinking and the corneal barrier limit how much of a drop enters the eye, and drained fluid is absorbed systemically. Frequency, order and contact time matter.

No steroids in an ulcer
A steroid delays corneal healing and may cause melting. Stain with fluorescein before choosing any anti-inflammatory.

Pressure is production minus outflow
Glaucoma drugs either reduce aqueous production or increase drainage. Atropine, which can raise pressure, is avoided.

Check the eardrum first
A ruptured tympanum lets otic drugs reach the inner ear, so ototoxic drugs and strong cleaners become dangerous.

Memory aid: STAIN before STEROID
Stain the cornea with fluorescein before any steroid is considered. If the stain is taken up, the steroid is not used.

Compare and contrast

Atropine and tropicamide

Feature	Atropine	Tropicamide
Duration	Days	Hours
Main use	Uveitis pain, deep ulcers, preventing synechiae	Diagnostic pupil dilation
Bitter taste and salivation	Common, especially in cats	Less common
Glaucoma	Contraindicated	Use with caution, check pressure
Horse concern	Reduced gut motility, colic risk	Less concern

Glaucoma drug groups

Group	Effect on pressure	Example	Key caution
Carbonic anhydrase inhibitor	Less aqueous produced	Dorzolamide	Oral forms disturb acid-base and electrolytes
Prostaglandin analogue	More outflow, miosis	Latanoprost	Avoid in uveitis and lens luxation
Beta-blocker	Less aqueous produced	Timolol	Slow heart, airway effects
Osmotic diuretic	Water drawn out of eye	Mannitol	Needs hydration and cardiac check, short effect

Species notes

Dog

Dry eye is common and usually immune-mediated. Primary glaucoma is often bilateral, and prostaglandin analogues work well.

Cat

Feline herpesvirus is a major cause of eye disease. Atropine causes marked drooling, and beta-blockers need care in cats with heart or airway disease.

Horse

Cattle

Ulcers can become fungal and melt quickly. Atropine can reduce gut motility, so watch for colic signs, and treat any painful eye as urgent.

Pinkeye is common and spreads in groups with flies and dust. Observe withdrawal for any eye or injected treatment.

Rabbits and small mammals
Many rabbits have atropine-splitting enzymes, so atropine may work poorly. Eye drugs for these species should follow species-specific advice.

Clinical pearls

Self-test: 10 questions

1. Why can topical eye drops cause systemic effects?

Excess fluid drains through the nasolacrimal duct to the nose and throat, where it is absorbed.

2. In which order should an eye drop and an eye ointment be given?

Ointment can block later drops, so drops go first with a short interval and the ointment last.

3. Which drug group is contraindicated in a corneal ulcer?

Steroids delay healing and may cause melting of the cornea.

4. Which test should precede the use of any topical steroid in the eye?

Fluorescein uptake reveals a corneal ulcer, which rules out steroids.

5. Which statement about atropine is correct?

Atropine is a long-acting muscarinic blocker; the bitter taste and gut effects are well known, and it is avoided in glaucoma.

6. Which drug is mainly used as a short-acting diagnostic mydriatic?

Tropicamide acts for hours and is used for examination.

7. Latanoprost lowers intraocular pressure mainly by:

Prostaglandin analogues increase outflow and constrict the pupil.

8. When should a prostaglandin analogue be avoided?

These drugs can worsen inflammation and lens-related obstruction.

9. Why must the tympanic membrane be assessed before using otic drugs?

In perforation, drugs such as aminoglycosides and chlorhexidine can damage hearing and balance.

10. A farmer treats pinkeye in a dairy cow. What should the vet advise?

Residues in milk and meat matter even for eye treatments, so the label and current rules apply.

Key points to revise

1. Topical ocular drugs have poor contact time and may be absorbed systemically through the nasolacrimal duct.

2. Ointments last longer but blur vision, and should be given after drops.
3. Corticosteroids are contraindicated in a corneal ulcer.
4. Atropine acts for days and tropicamide for hours; atropine is avoided in glaucoma.
5. Glaucoma drugs reduce aqueous production or increase outflow.
6. Prostaglandin analogues are avoided in uveitis and anterior lens luxation.
7. Ear drugs need an intact tympanic membrane check because of ototoxicity.
8. Owners should avoid leftover human eye and ear drops and must be taught how to dose properly.

Go deeper on this site

- Ch 3. Vitamins and minerals in therapy (in this book)
- Ch 1. Dermatological drugs (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Index
- Veterinary Drug Concepts Clearly Explained

Sources

- Merck Veterinary Manual, Eye Diseases and Disorders
- Merck Veterinary Manual, Ear Disorders
- Merck Veterinary Manual, Pharmacology

CHAPTER 3 OF 7

Vitamins and minerals in therapy

Vitamins and minerals are nutrients, but in practice they are used as drugs: given to correct deficiency, and capable of causing harm when overdone. This chapter explains fat- and water-soluble vitamins, key trace minerals, the narrow gap between deficiency and toxicity, and sensible supplementation in livestock.

After this chapter you can

- Contrast fat-soluble and water-soluble vitamins in storage, toxicity risk and dosing logic
- Explain how ruminants differ from dogs, cats and poultry in vitamin supply

- Describe the main deficiency and toxicity syndromes of copper, selenium, zinc, iron, iodine and cobalt at concept level
- Explain why a trace mineral can be deficient and toxic at nearby intake levels, and why species differ
- Give practical advice to a farmer on supplement use, labels, and avoiding duplication

Why nutrients are treated as drugs

Vitamins and minerals are needed in small amounts for enzymes, membranes, bone, blood and immunity. When intake is too low, a deficiency disease appears. When intake is too high, a toxicity appears. A feed-grade or injectable supplement is therefore a drug with a **narrow therapeutic window**, and it should be chosen with the same care as an antibiotic.

A useful habit is to ask three questions before supplementing. Is there a real deficiency, from the diet, soil or region? Is there an *interference* that blocks absorption or use, even when intake looks adequate? Is the animal already receiving the same nutrient from another product? Many field problems come from the third question, because mineral mixtures, injectables and feed premixes often overlap.

Fat-soluble vitamins: A, D, E and K

These vitamins dissolve in fat, are absorbed with dietary lipid, and are **stored** in liver and fat. Storage protects against short gaps in the diet, but it also means that repeated large doses can accumulate to toxic levels.

- **Vitamin A** supports vision, epithelial health, reproduction and immunity. Deficiency causes night blindness, poor growth and rough epithelium. Excess is harmful, and in pregnancy it can damage the developing foetus. Cats cannot convert plant carotene into vitamin A, so they need it preformed in the diet.
- **Vitamin D** raises calcium and phosphorus absorption and supports bone. Deficiency gives rickets in young animals and osteomalacia in adults. Excess causes high blood calcium and calcification of soft tissues, kidneys and vessels. Cholecalciferol rodenticides poison animals by this exact mechanism.

- **Vitamin E** is an antioxidant that protects cell membranes. It works closely with selenium, so deficiency of either gives overlapping muscle and reproductive disease.
- **Vitamin K** is needed to make clotting factors. Gut bacteria make some, so deficiency is uncommon, but it appears when anticoagulant rodenticides or spoiled sweet clover (dicoumarol) block its recycling. Treatment replaces vitamin K, which then restores clotting factors, but only after a lag while new factors are made.

Water-soluble vitamins: B complex and C

Water-soluble vitamins are not stored in large amounts; excess is mostly excreted in urine. They are therefore safer in overdose, but a diet that lacks them causes deficiency within days to weeks. A common confusion is to say they are "completely safe". Safer does not mean harmless, and repeated injections still carry cost, injection-site and product-quality issues.

Ruminants are a special case. Rumen microbes make B vitamins, and vitamin C is made in tissues by most domestic species, so routine deficiency is uncommon. Two exceptions matter in practice. **Thiamine (B1)** deficiency causes cerebrocortical necrosis (polioencephalomalacia) when the rumen is disturbed, for example by thiaminase-producing microbes, high-concentrate feeding or excess dietary sulphur. Early treatment with thiamine can be life-saving. **Vitamin B12** needs **cobalt** for its synthesis by rumen microbes, so cobalt-poor pastures produce a B12 deficiency with poor appetite and wasting.

In dogs and cats, deficiency usually follows an unbalanced home-made or restricted diet. Cats fed raw fish containing thiaminase can develop thiamine deficiency with neurological signs. In poultry, riboflavin deficiency gives curled-toe paralysis in chicks. Vitamin B supplements are often given alongside antibiotics or in anorexic patients, which is reasonable when the intake is truly low.

Trace minerals: what each does and how it fails

Trace minerals work as parts of enzymes or hormones. Link each to a function and the disease is easier to remember.

- **Selenium** is part of glutathione peroxidase and protects cells from oxidative damage. Deficiency causes nutritional muscular dystrophy (white muscle disease) in calves, lambs and foals, and retained placenta and weak neonates. Excess causes chronic and acute toxicity; the gap between adequate and toxic intake is small, and soil selenium varies widely by region.
- **Copper** is needed for pigment, connective tissue, iron handling and the immune system. Deficiency gives anaemia, poor growth, faded coat and bone problems. Sheep accumulate copper in the liver and are especially prone to toxicity, which ends in sudden haemolysis; cattle tolerate more, but are not immune.
- **Zinc** supports skin, hoof and immunity. Deficiency causes parakeratosis, particularly in pigs fed diets high in calcium. Large oral zinc intake can cause toxicity, for instance from swallowed metal objects.
- **Iron** carries oxygen. Suckling piglets are born with low stores and the sow's milk is poor in iron, so iron is given to prevent anaemia. Overdose of iron is toxic to the gut and liver.
- **Iodine** is needed for thyroid hormones; deficiency causes goitre and weak or stillborn young.
- **Cobalt** is needed by rumen microbes to make vitamin B12, as above.

Deficiency, toxicity and interference

The key idea is the **dose-response curve with two ends**. Below the requirement, performance falls; there is a comfortable plateau; above the tolerance limit, harm appears. For selenium and copper, the plateau is narrow, so "a little extra to be safe" is a bad habit.

Absorption is also controlled by **antagonists**. High molybdenum and sulphur in forage lock up copper in ruminants and produce a secondary copper deficiency, even when copper content looks normal. Excess calcium reduces zinc availability. Excess of one mineral can therefore cause deficiency of another, and the cure for deficiency is sometimes to remove the antagonist rather than to add more mineral.

Species matter. Sheep tolerate little copper. Cats need preformed vitamin A. Ruminants rely on rumen synthesis for most B vitamins. Dogs and cats are often poisoned by human multivitamins, where iron, vitamin D or other ingredients can reach harmful amounts relative to body weight, so owners should not share human supplements with pets without veterinary advice.

Diagnosis rests on history, ration review, signs and, where available, blood, liver or feed analysis. Treatment by guess often fails because the problem is an antagonist, a different mineral, or a non-nutritional cause.

Supplements in livestock: practical use

Supplements reach animals in three ways: **feed premixes and mineral mixtures**, **water-soluble powders** and **injectables**. Each has a logic. Mixtures suit herd-level, long-term correction. Injectables act faster and are used for an individual deficiency or a high-risk moment, such as selenium and vitamin E for newborns in deficient areas, or iron for piglets. Water-soluble products suit poultry flocks but are consumed unevenly when water intake falls in hot weather.

What to tell the farmer:

1. Use a product designed for the species. A mineral mixture made for cattle may be unsafe for sheep because of its copper content.
2. Read the label for what is in the mixture and avoid adding a second product that duplicates it.
3. Store vitamin products away from heat, light and moisture, since several vitamins break down and the label strength is lost.
4. Correct the cause, such as feed quality, water, parasites or antagonists, rather than depending on repeated injections.
5. Ask for a ration review when the same problem recurs.

Residues are a secondary concern for most vitamins and minerals, but injectable products and high-dose preparations still carry label instructions. Follow the label withdrawal period where given, and check the current regulatory notification for any specific limits. Do not assume that a nutrient has no waiting period only because it is a vitamin.

Concept cleared

Storage decides safety

Fat-soluble vitamins are stored, so excess builds up and can poison. Water-soluble vitamins are mostly excreted, so overdose is less dangerous but not harmless.

Two-sided dose-response

Every nutrient has a deficient range, an adequate range and a toxic range. For selenium and copper the adequate range is narrow.

Interference gives secondary deficiency

Molybdenum and sulphur reduce copper availability in ruminants, and excess calcium reduces zinc. Removing the antagonist can be the correct therapy.

Rumen changes the rules

Rumen microbes make B vitamins if cobalt is available, so deficiencies in ruminants are uncommon except for thiamine disturbance and cobalt-related B12 deficiency.

Memory aid: Fat-soluble vitamins: ADEK

ADEK vitamins are stored in fat, so they can build up. Think A for Accumulates in the liver, D for Deposits calcium in soft tissue, E for Eats free radicals with selenium, K for Kills bleeding by making clotting factors.

Compare and contrast

Fat-soluble versus water-soluble vitamins

Feature	Fat-soluble (A, D, E, K)	Water-soluble (B complex, C)
Absorption	With dietary fat	Mostly direct, often by carriers
Body storage	Liver and fat	Little storage
Toxicity risk	Higher, by accumulation	Lower, excess excreted
Deficiency onset	Slow, after stores empty	Faster when intake stops
Example problem	Vitamin A excess, vitamin D calcification	Thiamine deficiency in ruminants and cats

Selected trace minerals

Mineral	Main role	Deficiency picture	Toxicity concern
Selenium	Antioxidant enzyme	White muscle disease, weak neonates	Narrow safe margin
Copper	Enzymes, pigment, iron use	Anaemia, poor coat, poor growth	Sheep, sudden haemolysis
Zinc	Skin, hoof, immunity	Parakeratosis	Gut and organ damage with excess
Iron	Oxygen transport	Piglet anaemia	Gut and liver injury
Iodine	Thyroid hormones	Goitre, weak young	Disturbed thyroid function
Cobalt	Rumen B12 synthesis	Wasting, poor appetite	Rare

Species notes

Cattle and buffalo

Rumen makes B vitamins if cobalt is present. Watch for copper antagonism by molybdenum and sulphur, and for selenium-responsive disease in deficient regions.

Sheep and goats

Sheep are highly susceptible to copper toxicity, so mineral mixtures designed for cattle can be dangerous. Thiamine-responsive brain disease follows rumen disturbance in small ruminants.

Pigs

Piglets need iron early because of low stores and low milk iron. High dietary calcium raises the risk of zinc-responsive parakeratosis.

Poultry

Rapid growth makes birds sensitive to deficiency of vitamin E and selenium, and of riboflavin. Water-soluble supplements depend on water intake.

Dogs and cats

Cats need preformed vitamin A and are sensitive to thiamine loss from raw fish. Human multivitamins can poison pets, mainly through iron and vitamin D.

Clinical pearls

Self-test: 10 questions

1. Which statement about fat-soluble vitamins is correct?

Fat-soluble vitamins are absorbed with lipid and stored, which is why excess can accumulate.

2. A calf in a selenium-deficient area shows stiffness and weakness with muscle damage. The most likely condition is

Selenium and vitamin E deficiency produce nutritional muscular dystrophy.

3. Which species is most sensitive to copper toxicity?

Sheep accumulate copper in the liver and may undergo sudden haemolysis.

4. High molybdenum and sulphur in forage mainly cause

These antagonists bind copper in the rumen and reduce availability.

5. Cobalt is needed in ruminants because it

Without cobalt, rumen B12 synthesis falls and deficiency follows.

6. Cholecalciferol rodenticide poisoning acts mainly by

Excess vitamin D increases calcium and phosphorus and causes mineralisation of soft tissues.

7. Why do cats need preformed vitamin A?

Cats lack adequate conversion of carotene to vitamin A, so animal-source vitamin A is required.

8. Which problem is linked to thiaminase or excess sulphur in ruminants?

Thiamine deficiency or interference causes cerebrocortical necrosis.

9. A farmer wants to add a second mineral product on top of a mineral mixture already fed. The best first advice is

Duplicate intake of selenium or copper can push animals into the toxic range.

10. Why are water-soluble vitamins in drinking water less reliable in a hot spell?

Dose received depends on water consumption, which changes with weather and illness.

Key points to revise

1. Vitamins and minerals have narrow windows and should be used with drug-like care.
2. Fat-soluble vitamins are stored and can accumulate to toxic levels.
3. Water-soluble vitamins are mostly excreted but are not free of problems.
4. Vitamin D excess causes soft-tissue calcification.
5. Selenium and vitamin E work together against oxidative muscle damage.
6. Ruminants make B vitamins in the rumen if cobalt is available.
7. Sheep are very susceptible to copper toxicity.
8. Supplements should match the species and not duplicate other products.

Go deeper on this site

- Ch 4. Fluid, electrolyte and acid-base therapy (in this book)
- Ch 2. Ophthalmic and otic drugs (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Index
- Veterinary Drug Concepts Clearly Explained

Sources

- Merck Veterinary Manual: Nutritional Requirements of Dairy Cattle
- Merck Veterinary Manual: Toxicoses in Animals From Human Multivitamins and Supplements
- Merck Veterinary Manual: Nutritional Requirements of Small Animals

CHAPTER 4 OF 7

Fluid, electrolyte and acid-base therapy

Fluid therapy is often the most life-saving treatment in a sick animal, but the wrong fluid or the wrong speed can do harm. This chapter covers how to judge dehydration, how crystalloids and colloids differ, how to correct potassium and calcium safely, and when oral rehydration is enough.

> ### After this chapter you can

- Distinguish dehydration from hypovolaemia and assess each at the bedside
- Compare crystalloids and colloids and match fluid type to the problem
- Explain the safety rules for correcting potassium and calcium
- Relate common clinical conditions to acid-base disturbances and the role of buffers in fluids
- Explain how oral rehydration works and what to tell a farmer or owner

Why fluids come first

Body water is divided into **intracellular** fluid and **extracellular** fluid; the extracellular part includes plasma (inside vessels) and interstitial fluid (between cells). Vomiting, diarrhoea, bleeding, heat, burns and poor intake remove fluid and electrolytes. When enough is lost, blood flow to organs falls, the kidneys are injured and drugs that depend on perfusion and renal clearance behave unpredictably.

Many drug problems begin with a dehydrated patient. A nephrotoxic antibiotic or an NSAID is much more dangerous in a dehydrated animal, so correcting hydration is part of drug safety, not only supportive care.

Two different problems must be separated. **Dehydration** is loss of water from the interstitial and cell compartments; it develops slowly and is corrected over hours. **Hypovolaemia** is a shortage of circulating blood volume; it is an emergency that needs rapid restoration. An animal can have one without the other.

Assessing dehydration and perfusion

Bedside assessment combines several signs, because no single sign is reliable. For **hydration** look at skin tent (skin returning slowly to place), dryness of the mucous membranes, and how deeply the eyes sit in the orbit. In calves, eye recession and loss of suckle reflex are practical signs. Elastic skin is less reliable in old, thin or obese animals, and in young animals the skin tent can mislead.

For **perfusion** check heart rate, pulse quality, capillary refill time, mucous membrane colour, limb temperature and mental state. Cold limbs, weak pulses and depression point to poor circulation. Laboratory help includes packed cell volume with total protein, which rise with water loss (unless there is anaemia or protein loss), plus urea, creatinine, electrolytes and blood gas where available.

The plan then has parts: replace the deficit, cover daily maintenance needs, and add replacement for continuing losses such as ongoing diarrhoea. Re-assess repeatedly, because the patient, not a formula, tells you when enough has been given. Signs of too much fluid include nasal discharge, increased respiratory effort, chemosis (swollen conjunctiva), and rising body weight; stop or slow the infusion if these appear.

Crystalloids and colloids

Crystalloids are solutions of small molecules that move freely across the vessel wall, so most of the volume leaves the blood within a short time. They are the main fluids for replacement and maintenance.

- **Replacement isotonic crystalloids** (for example Ringer's lactate, Hartmann's solution and other balanced solutions) have electrolyte content similar to extracellular fluid and contain a buffer, such as lactate or acetate, that is converted to bicarbonate. They are the usual first choice in diarrhoea and most dehydration.
- **0.9% saline** has sodium and chloride only. It suits some metabolic alkaloses with chloride loss and certain high-potassium states. Large volumes can cause a chloride-related acidosis.
- **Dextrose solutions** are mainly a source of free water and a little energy, since glucose is metabolised. They do not restore circulating volume well, and are not for shock.
- **Hypertonic saline** draws water into the vessels from other compartments and gives a short, quick rise in volume. It is used in selected emergencies, and its effect is brief, so isotonic fluid should follow.

Colloids contain large molecules that stay in the vessels and hold water there by oncotic pressure. They include plasma, albumin and synthetic products. They are used when low protein or ongoing leak is a problem, or to give a longer-lasting volume effect. Concerns about bleeding tendency and kidney injury with some synthetic colloids have led to restrictions in some countries, so check current guidance and product labelling before use.

A common confusion is that a litre of crystalloid is a litre of blood volume. It is not; only a fraction stays in the vessels, which is why larger volumes of crystalloid are

needed than of colloid.

Correcting potassium and calcium safely

Potassium and calcium are dangerous to correct fast, because both control heart rhythm.

Hypokalaemia follows anorexia, vomiting, diarrhoea, and increased urine loss; in cattle it occurs in downer cows and with some metabolic disease. Muscle weakness is the typical sign. Potassium is added to fluids at a controlled, limited rate, and it is **never given as a rapid intravenous push**, which can stop the heart. Follow the formula on a reliable reference, and monitor serum potassium and ECG where possible.

Hyperkalaemia occurs in urinary obstruction, kidney failure and Addisonian crisis. It causes bradycardia and characteristic ECG changes (tall T waves, flat P waves). Calcium gluconate protects the heart muscle quickly but does **not lower** the potassium level; its effect is brief. Insulin with glucose, and in some cases bicarbonate, move potassium into cells. The real cure is removing the cause, such as relieving the obstruction.

Hypocalcaemia, including milk fever in dairy cows, is treated with slow intravenous calcium. Auscultate the heart during the infusion, and stop at once if the heart rate slows, rhythm becomes irregular or the animal becomes distressed. Calcium injected outside the vein damages tissue, and calcium should not be mixed carelessly with other drugs or with certain fluids.

Acid-base disturbances in practice

Acid-base status reflects the balance between acids and bicarbonate, and the lungs control carbon dioxide. Four simple patterns cover most cases.

- **Metabolic acidosis**: bicarbonate loss or acid gain. Examples are diarrhoea in calves, shock with lactic acid build-up, kidney failure and ketoacidosis. Calves with diarrhoea may show depression and weak suckle largely because of acidosis, not only dehydration.
- **Metabolic alkalosis**: acid or chloride loss. Examples are vomiting of stomach contents in dogs and abomasal displacement or outflow obstruction in cattle, usually with low chloride and potassium.

- **Respiratory acidosis**: poor ventilation, for example under anaesthesia.
- **Respiratory alkalosis**: over-breathing from pain, fever or heat.

Most acid-base problems improve when the **underlying cause and perfusion** are corrected, since restored blood flow lets the liver and kidneys clear acid. Balanced fluids with a buffer help, and sodium bicarbonate is reserved for selected severe or persistent acidosis because over-treatment can cause alkalosis, low ionised calcium and fluid overload. Lactate-containing fluids can be less suited to animals with severe liver failure, as lactate is cleared by the liver.

Oral rehydration and advice to the owner or farmer

When the gut still works, the oral route is safe, cheap and often enough. Sodium and glucose are absorbed together by a shared carrier in the small intestine, and water follows. Because this carrier keeps working in infectious diarrhoea, a solution containing **sodium, glucose and an alkalinising agent** can rehydrate a calf, kid or lamb at home or in the shed. Good products also supply potassium and, in some, amino acids.

Practical points:

1. Use a commercial or recommended mix prepared exactly as the label states. Wrong dilution can worsen diarrhoea.
2. Continue to **offer milk** or milk replacer unless the veterinarian says otherwise; withholding food slows recovery and weakens the animal. Feed the electrolyte solution between milk feeds, not mixed in the same bottle unless the label allows.
3. Do not rely on plain water, salt-and-sugar guesses or home mixes without a tested recipe.
4. Call the veterinarian early if the calf cannot stand or suck, has cold limbs or a very sunken eye, is bloated, or has blood in stool. These animals need intravenous therapy.

For dogs and cats, mild dehydration with an animal that can still drink and keep fluid down may be managed with oral fluids under advice, but vomiting, collapse or a very young or old patient needs veterinary care. Fluid therapy should always be accompanied by finding the cause of the loss.

Concept cleared

Dehydration is not hypovolaemia

Dehydration is water loss from tissues and develops slowly; hypovolaemia is low circulating volume and needs rapid correction. Assess both.

Fluid type follows the problem

Balanced isotonic crystalloids for replacement, colloids for sustained plasma volume, dextrose for free water, hypertonic saline for brief emergency volume.

Cardiac safety governs electrolyte correction

Potassium and calcium both change heart rhythm, so they are given slowly, with monitoring, and never as a quick potassium push.

Oral route uses sodium-glucose coupling

Intestinal sodium-glucose co-transport still works in diarrhoea, so a correct oral electrolyte solution can rehydrate animals that can still suck and swallow.

Memory aid: Safe electrolyte rules: SLOW K and CA

Potassium and calcium both go SLOW and with a stethoscope or ECG. Remember K is never a push, and calcium is stopped if the heart slows.

Compare and contrast

Crystalloids versus colloids

Feature	Crystalloids	Colloids
Main particles	Small ions and glucose	Large molecules
Stay in vessels	Only a fraction	Longer retention
Main use	Replacement and maintenance	Low protein, sustained volume
Cost and availability	Cheaper, widely available	Costlier, may be restricted
Main concern	Fluid overload, oedema	Bleeding tendency, kidney concerns with some products

Common fluids at a glance

Fluid	Main feature	Typical use	Caution
Balanced isotonic solution	Electrolytes plus buffer	Most dehydration	Lactate in severe liver failure
0.9% saline	Sodium and chloride	Chloride-losing alkalosis, some hyperkalaemia	Large volumes may cause acidosis
Dextrose solution	Free water and energy	Water deficit, some energy needs	Poor volume expander
Hypertonic saline	Draws water into vessels	Selected emergencies	Brief effect; follow with isotonic fluid

Species notes

Cattle and buffalo

Calves with diarrhoea are mainly acidotic and need alkalinising oral solutions or intravenous therapy if they cannot suck. Milk fever needs slow intravenous calcium with heart monitoring.

Sheep and goats

Small body size makes fluid overload easy, so volumes and speed need extra care. Urinary obstruction in males can cause high potassium.

Horses

Pigs and poultry

Large fluid losses in colic or diarrhoea are corrected with large volumes of balanced crystalloid, usually through a catheter, with attention to electrolytes.

Group treatment is by drinking water, which depends on intake; sick animals drink less. Individual intravenous therapy is rarely practical.

Dogs and cats

Cats are prone to fluid overload and to potassium problems with kidney disease and urinary obstruction. Monitor respiration and weight during therapy.

Clinical pearls

Self-test: 10 questions

1. Dehydration differs from hypovolaemia because dehydration

Hypovolaemia is circulating volume shortage and needs rapid correction; dehydration is gradual tissue water loss.

2. Which finding most supports dehydration in a calf?

Eye recession and delayed skin return are practical hydration signs.

3. Why can large volumes of crystalloid be needed in shock?

Crystalloids redistribute quickly out of the vessels.

4. Which fluid is poor at restoring circulating volume?

Glucose is metabolised, leaving mostly free water that spreads through all compartments.

5. The safe rule for potassium supplementation is that it

Fast potassium can cause cardiac arrest.

6. In hyperkalaemia with bradycardia, calcium gluconate

Calcium stabilises cardiac membranes but potassium must be shifted or removed by other means.

7. During intravenous calcium for milk fever, the priority is to

Calcium affects cardiac rhythm and extravasation damages tissue.

8. Vomiting of stomach contents typically causes

Loss of hydrochloric acid and chloride raises bicarbonate relative to acid.

9. Why can oral rehydration work in infectious diarrhoea?

The co-transporter remains functional and draws water along with sodium.

10. A farmer's calf with diarrhoea cannot stand and has cold limbs. The best advice is to

Such calves are acidotic, hypovolaemic and unlikely to absorb oral fluid adequately.

Key points to revise

1. Separate dehydration from hypovolaemia.

2. Use several clinical signs together to assess hydration.
3. Balanced isotonic crystalloids are the usual first choice for replacement.
4. Colloids stay in vessels longer; check current guidance on synthetic products.
5. Potassium is never given as a rapid push.
6. Calcium is given slowly with heart auscultation.
7. Treat the cause of acid-base disturbance and restore perfusion.
8. Oral rehydration works through sodium-glucose co-transport and should be paired with continued milk feeding.

Go deeper on this site

- Ch 5. Nutraceuticals, herbal and ethnoveterinary medicine (in this book)
- Ch 3. Vitamins and minerals in therapy (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Index
- Veterinary Drug Concepts Clearly Explained

Sources

- Merck Veterinary Manual: The Fluid Resuscitation Plan in Animals
- Merck Veterinary Manual: Maintenance Fluid Plan in Animals
- Merck Veterinary Manual: Nutritional Requirements of Dairy Cattle

CHAPTER 5 OF 7

Nutraceuticals, herbal and ethnoveterinary medicine

How to think about herbal products, nutraceuticals and traditional farmer remedies with the same rigour used for any drug: what counts as evidence, where the real hazards lie, how they interact with licensed drugs and what to tell the owner or farmer.

After this chapter you can

- Distinguish a nutraceutical, a herbal product and an ethnoveterinary practice, and state what level of evidence each usually has
- Explain why 'natural' does not mean safe, using species-specific examples

- Describe how herbal and nutraceutical products can interact with conventional drugs
- Explain why residues and withdrawal remain a concern in food animals even for plant products
- Counsel a farmer or owner honestly about a traditional remedy without dismissing it

Why this topic needs a clear head

Farmers and pet owners in India use herbal and traditional remedies every day. Turmeric paste on a wound, neem leaves for skin disease, jaggery and ajwain for a bloated calf, and a long list of commercial herbal tonics are all common. A veterinarian will meet these practices at almost every clinic visit, so the aim is neither to ban them nor to accept them blindly.

The useful approach is to ask the same questions about a plant product that you ask about any drug. What is the active constituent? Is there evidence that it works in this species? What is the safe range? Does it interact with other drugs? What happens to its residues in milk, meat or eggs?

A **nutraceutical** is a food-derived or supplement-type product given for a health benefit beyond basic nutrition, such as omega-3 fatty acids, glucosamine, probiotics or silymarin. A **herbal product** is made from plant material and usually contains a mixture of many compounds. **Ethnoveterinary medicine** is the traditional knowledge that communities use to treat their own animals. These three overlap, but they differ in how well they have been tested.

What counts as evidence

Evidence comes in layers. At the top are well-designed controlled trials in the target species. Below them are small trials, trials in other species, laboratory studies and case reports. At the bottom is tradition alone. Many herbal remedies sit near the bottom for animals, and that is a statement about the evidence, not a proof that they do not work.

- **Laboratory activity is not clinical benefit.** A plant extract that kills bacteria in a dish may never reach that concentration in the animal, or may be destroyed in the rumen or gut.

- **Human data are not animal data.** Dogs, cats, ruminants and horses handle compounds differently, so a result in people cannot simply be carried across.

Another practical problem is **product variability**. The content of a plant depends on the variety, soil, season, part used and storage. Quality control of such products is uneven, and there have been reports in various countries of products found to contain undeclared conventional drugs. Be cautious with unlabelled mixtures.

Regulatory status of herbal and nutraceutical products for animals in India has been changing. Check the current notifications of the relevant authorities before you recommend, sell or label any such product.

Some commonly used agents and what is known

- **Turmeric (curcumin).** Widely used as an anti-inflammatory and wound remedy. Laboratory data are extensive, but curcumin is poorly absorbed, so the clinical benefit in animals is less clear than the laboratory data suggest. Topical use is generally low risk.
- **Neem.** Used on skin, as an insect repellent and as a general tonic. Neem products have shown activity against some parasites in laboratory work, but toxicity has been reported after excess or concentrated preparations, especially neem oil given by mouth. Treat 'a little is good so more is better' as a warning.
- **Garlic and onion (Allium species).** Sold as natural dewormers and immune boosters. These plants contain compounds that damage red cells and can cause Heinz body haemolytic anaemia, and dogs and cats are particularly vulnerable. Cats are especially sensitive.
- **Silymarin (milk thistle).** Used as a liver support. It has some supporting data, mostly from small studies, and is a reasonable low-risk adjunct beside proper treatment of the cause.
- **Glucosamine, chondroitin and omega-3 fatty acids.** Used for joint disease in dogs. Evidence is mixed in quality, with omega-3 fatty acids having comparatively better support. They support, and do not replace, analgesia and weight control.
- **Aloe vera.** The inner gel is used on wounds. The leaf latex contains anthraquinones that act as strong laxatives, so whole-leaf products given by mouth are not harmless.

Safety: natural is not the same as safe

A plant is a chemical factory, and many of its products evolved to deter animals from eating it. Several points matter in practice.

Species differences. Cats are deficient in some glucuronidation pathways, so many essential oils and phenolic compounds persist and accumulate. Tea tree oil and concentrated oils applied to the skin or diffused indoors have caused poisoning in cats and dogs. Dogs and cats react to Allium plants as described above.

Dose and concentration. A herbal extract is not a kitchen spice. Concentrated extracts and oils carry a different risk from the whole leaf.

Organ effects. Some plants carry hepatotoxic compounds such as pyrrolizidine alkaloids. A liver already damaged by disease is more vulnerable, so 'liver tonics' of unknown content in a jaundiced animal deserve care.

Delay in proper care. The commonest harm from herbal use is not poisoning but time lost. A calf with bacterial pneumonia or a cow with acute bloat can die while a home remedy is tried. Teach farmers the signs that mean 'call the veterinarian now'.

Interactions and residues

Herbal products are pharmacologically active, so they can interact with conventional drugs. The mechanisms are the same ones met earlier in the book.

- **Metabolism.** Some plant compounds induce or inhibit liver enzymes and drug transporters such as P-glycoprotein. Studies in people with St John's wort are a classical example, and similar concerns apply to veterinary patients, although species-specific data are limited.
- **Additive effects.** A sedative herb with a sedative drug, or a herb that affects blood clotting with an anticoagulant or an NSAID, may add up. Fish oil is sometimes discussed in this context; be careful before surgery or in bleeding disorders.

Residues. This is a point students often miss. A plant origin does not remove the need for a withdrawal period. For most herbal products no withdrawal period or maximum residue limit has been established, and that means *unknown*, not *zero*. In animals that produce milk, meat or eggs, ask what was given, when and how much, and take a cautious approach. Where a conventional drug is also in use, the

withdrawal period of that drug still applies. Check the current rules and notifications of the Indian authorities for residues and for any permitted herbal products in food animals.

Ethnoveterinary practice in India and talking to farmers

India has a deep tradition of ethnoveterinary knowledge, and national institutions and universities have documented many practices for conditions such as mastitis, wounds, diarrhoea, retained placenta and parasites. This documented knowledge is a valuable source of hypotheses and may be the only affordable option in some places, so treat it with respect while still checking it.

A good consultation follows a simple sequence.

1. **Ask without judgement.** Farmers hide what they have given if they expect a scolding. Ask 'what have you already tried?'
2. **Record it.** Note the product, amount, route and duration, particularly if the animal produces milk or goes for slaughter.
3. **Sort the remedies.** Harmless and possibly helpful (warm compresses, clean water, jaggery), uncertain, and harmful (oral oils in a distressed animal, force-drenching a recumbent animal, caustic wound applications).
4. **Never delay the effective treatment.** For a serious condition, proper care goes first, and a harmless traditional practice can sit beside it.
5. **Explain residues.** Say plainly that milk and meat can carry drug residues and that unknown mixtures have no tested safe waiting time.

The honest message is: some traditional remedies are harmless, a few may help, some are harmful, and most have not been tested well enough to say. Our job is to find out which is which for the animal in front of us.

Concept cleared

Evidence ladder

Controlled trials in the target species are strongest. Laboratory results, human data and tradition are weaker and cannot be taken as proof of benefit in the animal.

Natural is not safe

Plant products are active chemicals. Concentration, species and the state of the liver and kidney decide whether a plant product helps or harms.

Unknown is not zero

A herbal product with no established withdrawal period has an unknown residue risk, which must be treated cautiously in food animals.

Interactions follow normal pharmacology

Herbal compounds can induce or inhibit metabolism, add to the effects of drugs or reduce absorption, exactly as conventional drugs do.

Memory aid: Questions to ask about any plant product: WHAT-EVIDENCE

Ask: What is in it, How much, Any proof in this species, Toxicity, Interactions, Residues and withdrawal. Never skip the last two in food animals.

Compare and contrast

Nutraceutical, herbal product and ethnoveterinary practice

Feature	Nutraceutical	Herbal product	Ethnoveterinary practice
Typical source	Food-derived or supplement compounds	Plant material, often mixed	Community knowledge using local plants and methods
Standardisation	Often defined content	Variable, may be unstandardised	None, depends on the preparer
Evidence	Mixed, some trials	Mostly laboratory and tradition	Documented tradition, limited testing
Main concern	Quality and overstated claims	Variability, toxicity, hidden drugs	Delay in proper care, unknown residues

Reasons a remedy appears to work

Explanation	Meaning	How to check
True pharmacological effect	The compound acts on the disease	Controlled trial in the species
Natural recovery	The disease would have resolved anyway	Compare with an untreated control group
Co-treatment	A conventional drug was also given	Record every product used
Placebo and owner expectation	Perceived improvement	Blinded, objective outcomes

Species notes

Cats

Poor at conjugating many phenolic compounds, so essential oils, tea tree oil and some herbal oils are risky. Onion and garlic can damage red cells.

Dogs

Allium plants can cause Heinz body anaemia. Concentrated oils and extracts also carry risk, and xylitol-containing supplements are dangerous.

Cattle and buffalo

Milk is consumed daily, so any herbal or home remedy matters for residues. Large oral volumes in a weak animal risk aspiration.

Small ruminants

Plant dewormers and tonics are widely used by small farmers. Check parasite control with faecal egg counts rather than assuming a herbal drench works.

Poultry

Herbal feed and water additives are common. Eggs and meat are food, so unknown withdrawal remains a concern, and herbal products cannot replace biosecurity and vaccination.

Clinical pearls

Self-test: 10 questions

1. Which statement best describes an ethnoveterinary practice?

Ethnoveterinary medicine is traditional knowledge used by communities, which may or may not have been tested.

2. A plant extract kills bacteria in a laboratory dish. What is the correct conclusion?

Laboratory activity does not show that the compound reaches effective levels in the animal.

3. Garlic and onion are a particular concern in dogs and cats because they can cause

Allium compounds damage red cells and can cause Heinz body anaemia, with cats especially sensitive.

4. Why are essential oils and concentrated tea tree oil risky in cats?

Limited conjugation lets phenolic compounds accumulate to toxic levels.

5. A farmer gives a herbal mixture to a lactating cow. The label shows no withdrawal period. How should the veterinarian regard it?

No stated period means the residue risk is unknown, not absent.

6. Which is the commonest real harm from home remedies?

Time lost before proper care is the most frequent cause of harm.

7. A herbal product that induces hepatic enzymes may

Induction speeds metabolism, so drugs cleared by those enzymes can become less effective.

8. The best first step when a farmer mentions a traditional remedy is to

Open questions give the information needed and keep the farmer's trust.

9. Why can two bottles of the same herbal tonic act differently?

Lack of standardisation causes batch-to-batch variation.

10. Aloe vera leaf latex given orally is best described as

The latex contains anthraquinones with strong laxative action, unlike the inner gel used on wounds.

Key points to revise

1. Nutraceutical, herbal product and ethnoveterinary practice differ in standardisation and evidence.
2. Evidence from laboratory studies, other species or tradition is weaker than a controlled trial in the target species.
3. Natural does not mean safe; species, dose and concentration decide risk.
4. Cats are especially sensitive to essential oils and some plant phenolics.
5. Herbal products can interact with conventional drugs through metabolism, additive effects and absorption.
6. Most herbal products lack established withdrawal periods or residue limits, which means unknown risk in food animals.

7. Ask about, record and respect traditional practices, but never delay effective treatment.
8. Check the current Indian regulatory position before recommending or labelling herbal products for animals.

Go deeper on this site

- Ch 6. Feed additives, growth promoters and ionophores (in this book)
- Ch 4. Fluid, electrolyte and acid-base therapy (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Index
- Veterinary Drug Concepts Clearly Explained

Sources

- WHO: Antimicrobial resistance fact sheet
- WHO: One Health
- WOAH: Codes and Manuals

CHAPTER 6 OF 7

Feed additives, growth promoters and ionophores

What feed additives are, why antibiotic growth promoters are being phased out worldwide, how ionophores work and why they poison horses and dogs, and how residue and regulatory thinking applies to medicated feed.

After this chapter you can

- Classify feed additives and distinguish a nutritional additive from a drug
- Explain why antibiotic growth promoters were withdrawn and how that links to resistance
- Describe the mechanism and uses of ionophores in ruminants and poultry
- Explain why ionophores are toxic to horses, dogs and other species, and how accidents happen
- Explain residue and withdrawal logic for medicated feed and what to tell the farmer

What a feed additive is

A **feed additive** is a substance added to feed in small amounts to improve the feed, the animal's performance or the quality of the product. The line between a nutrient, an additive and a drug is thin and is decided by *purpose* and *law*. Vitamins and minerals correct a dietary need. Enzymes, probiotics, organic acids and toxin binders improve digestion or feed quality. Antimicrobials, coccidiostats and ionophores act on microbes and parasites, so they behave as drugs, and are treated by regulators with more care.

Regulation differs from country to country and is revised from time to time. In India, rules on feed quality, feed additives and the use of antimicrobials in animals sit with several authorities. Check the current notifications before advising a farmer or a feed manufacturer.

Remember one key idea: anything added to **feed** reaches every animal in the group, sick or healthy, at a dose that depends on how much each animal eats. That makes feed a poor route for precise dosing and a good route for accidents.

Antibiotic growth promoters and their phase-out

Decades ago it was found that giving very low levels of antibiotics in feed over a long time improved growth and feed efficiency in pigs and poultry. These are called **antibiotic growth promoters** (AGPs). The exact mechanism is not fully settled, but the effect is thought to come from changes in the gut microbiota and less sub-clinical infection.

The problem is that long, low-level exposure is the ideal condition for selecting resistant bacteria. Resistant organisms and resistance genes can reach people through food, direct contact and the environment. For this reason Sweden and later the European Union stopped AGP use, and the WHO has recommended that medically important antimicrobials should not be used in healthy animals to promote growth. Other countries, including the United States, have also restricted growth-promotion use of medically important antimicrobials.

India has also moved towards restricting antimicrobial use in animals, including action on colistin in animal production. The details change, so state them only as 'check the current notification'.

Common confusion: phase-out of AGPs does *not* mean that animals can never receive antibiotics. Treatment of sick animals under veterinary supervision remains allowed. What is being curtailed is routine use for growth. Good farm management, biosecurity, vaccination, clean water and balanced feed replace much of what AGPs did, and non-antibiotic alternatives such as probiotics, organic acids and enzymes are used. The evidence for these alternatives is variable.

Ionophores: what they are and how they work

Ionophores are antimicrobial compounds made by microbes. Examples include monensin, lasalocid, salinomycin, narasin and maduramicin. They are not used in human medicine, which is one reason they were long treated differently from antibiotics, although they are still managed carefully.

Mechanism. An ionophore is a fat-soluble molecule that binds cations such as sodium, potassium and calcium and carries them across cell membranes. This destroys the ion gradients the cell relies on, and the organism dies of energy and osmotic failure. Gram-positive bacteria and protozoa such as *Eimeria* are sensitive. Gram-negative bacteria are protected by their outer membrane.

Uses.

- **Poultry:** coccidiosis prevention in broilers and replacement pullets. Resistance can develop, and programmes are often rotated or combined with vaccines.
- **Cattle and small ruminants:** in the rumen, ionophores favour microbes that produce more propionate and less methane, improving feed efficiency and helping control coccidiosis. They can also reduce the risk of some forms of acidosis and bloat.

Safe use depends on correct mixing, a labelled species and a labelled dose. The margin of safety is narrow, which leads to the next section.

Ionophore toxicity

Ionophores damage **cardiac and skeletal muscle**, because the same disruption of ion balance occurs in muscle cells when the dose is too high or the animal is too sensitive. The species differ greatly in sensitivity.

- **Horses** are exceptionally sensitive, especially to monensin. Feed intended for cattle or poultry must never be fed to horses.
- **Dogs** are also sensitive, and cases follow access to poultry or cattle feed, or to litter and feed spill.
- **Other species**, including cats, sheep, goats, camelids, rabbits and turkeys, can also be affected. Some ionophores are tolerated by one species and are not by another, so use only products labelled for that species.

How accidents happen. Feed-mill cross-contamination, mixing errors, wrong feed bags, feeding the wrong ration to the wrong species, and use of poultry litter or feed residues as feed for other animals.

Signs. Anorexia, colic-like signs, weakness, a stiff or wobbly gait, sweating in horses, recumbency, dark urine from muscle breakdown, and signs of heart failure. Acute cases may die suddenly. Survivors can have lasting damage to the heart.

Management. There is no specific antidote. Remove the feed at once, call for urgent supportive care and monitor the heart and muscle enzymes. Binding agents may be used early after ingestion by veterinarians. Antioxidant treatment such as vitamin E has been discussed, but the evidence is limited. Prognosis depends on the amount eaten and on cardiac damage, so be guarded.

Drug interactions. Some drugs, notably tiamulin and certain macrolides, can slow hepatic metabolism of ionophores and cause toxicity at normally safe levels, particularly in poultry and pigs. Read the label for incompatible combinations before mixing.

Residues, withdrawal and medicated feed

A **residue** is the drug or its metabolites remaining in milk, meat, eggs or other products. A **maximum residue limit (MRL)** is the highest concentration regarded as acceptable in a food. A **withdrawal period** is the time after the last dose before the product can enter the food chain so that residues fall below the limit. Codex Alimentarius and national authorities set the standards. For India, check the current FSSAI and other notifications for MRLs and withdrawal times.

Medicated feed brings special problems.

- **Carry-over.** Traces of medicated feed left in mixers, conveyors and bins can contaminate the next batch, a cause of unintended residues and of toxicity in sensitive species.
- **Uneven intake.** Sick animals eat less, so they get less drug while healthy animals eat more.
- **Label discipline.** Use only for the labelled species, purpose and period. Some ionophores must not be given to laying hens producing eggs for human consumption, and some have a pre-slaughter withdrawal. Read the label.
- **Records.** Keep feed batch records, dates and the animals fed, so that a residue problem can be traced.

Residue violations carry economic, trade and public-health costs. Exports of meat and fish products may be rejected for residues.

What to tell the farmer or feed manufacturer

Give short, practical advice.

1. **Check the bag.** Is it labelled for your species? Never feed cattle or poultry feed to horses or dogs.
2. **Store separately** and keep animals and dogs away from feed stores.
3. **Do not use poultry litter or feed leftovers** as feed for other species unless a veterinarian has advised that it is safe and legal.
4. **Follow withdrawal times** and keep a written record.
5. **Do not use antibiotics as a routine growth booster.** Improve housing, hygiene, vaccination and nutrition, and use treatment only when needed and prescribed.
6. **If an animal becomes ill after a feed change** or a new batch, remove that feed, keep a sample, and call the veterinarian at once.

Keep a sample of the suspect feed. It lets the laboratory confirm the cause and protects the farmer if there is a dispute with the feed supplier.

Concept cleared

Purpose and law define an additive

A feed ingredient becomes a drug when its purpose is to affect microbes, parasites or disease, and it is then regulated more tightly.

Low-dose antibiotics select for resistance

Long sub-therapeutic exposure favours resistant bacteria, which is the reason for the global phase-out of growth promotion.

Ionophores carry ions across membranes

They collapse ion gradients in susceptible microbes and, at high exposure, in cardiac and skeletal muscle.

Feed reaches every animal

Medicated feed gives uneven dosing and carry-over risk, so label and mixing discipline matter.

Memory aid: Ionophore poisoning: HORSE-DOG-FEED

Horses and dogs are hit hardest. Think of feed errors first, and the heart and muscles as targets. Stop the feed, support the patient and keep the sample.

Compare and contrast

Ionophore sensitivity in different species

Species	Sensitivity	Typical route of exposure	Main target
Horse	Very high	Cattle or poultry feed	Heart and skeletal muscle
Dog	High	Poultry or cattle feed, spilled feed	Skeletal muscle, heart and nerves
Cattle	Tolerates labelled dose	Medicated ration	Overdose affects heart and muscle
Poultry	Tolerates labelled dose	Medicated feed	Interactions and overdose cause toxicity

Growth promotion versus treatment

Feature	Growth promotion	Therapeutic use
Animals	Healthy	Sick or in-contact at risk
Duration	Long, continuous	Defined short course
Supervision	Often none	Veterinary
Resistance risk	High, selective pressure	Lower if used correctly
Current trend	Being phased out or restricted	Allowed with prudent use

Species notes

Horses
Extremely sensitive to ionophores such as monensin. Cattle and poultry feed must be kept away from them.

Dogs
Poisoning follows eating poultry or cattle feed. Signs include weakness, muscle damage and heart problems.

Cattle and buffalo
Ionophores improve feed efficiency and control coccidiosis, but mixing errors can cause serious cardiac damage.

Sheep and goats
Use only products labelled for them, because sensitivity differs and some feeds designed for cattle may be unsafe.

Poultry
Ionophores control coccidiosis. Check withdrawal, avoid use in layers where the label forbids it and watch for interactions with tiamulin and some macrolides.

Clinical pearls

Self-test: 10 questions

1. The main public-health reason for phasing out antibiotic growth promoters is

Long, low-level exposure favours resistant organisms, which can reach people.

2. Which statement about the phase-out is correct?

The phase-out targets growth promotion, not treatment.

3. An ionophore acts by

Ionophores are lipid-soluble cation carriers.

4. Gram-negative bacteria are largely unaffected by ionophores because of

The outer membrane stops the ionophore reaching the inner membrane.

5. Which species is exceptionally sensitive to monensin?

Horses are the classical highly sensitive species.

6. The tissues mainly damaged in ionophore poisoning are

Disrupted ion balance damages muscle cells.

7. A common way dogs and horses are poisoned is

Accidental access to cattle or poultry feed is the typical cause.

8. Tiamulin with an ionophore may

Some drugs inhibit hepatic metabolism and raise ionophore toxicity.

9. What is a withdrawal period?

It allows residues to fall below the MRL.

10. After suspected ionophore poisoning the first action is to

Stopping exposure and keeping a sample are essential.

Key points to revise

1. Feed additives range from nutrients to drugs, and regulation depends on purpose.
2. Antibiotic growth promoters select for resistance and are being restricted or banned in many countries.
3. Check the current Indian notifications on antimicrobial use in animal feed.
4. Ionophores move cations across membranes and kill Gram-positive bacteria and coccidia.
5. Horses and dogs are very sensitive to ionophores, and toxicity targets heart and skeletal muscle.
6. Tiamulin and some macrolides can raise ionophore toxicity by slowing metabolism.
7. Medicated feed carries risks of carry-over, uneven intake and residues.
8. Follow labels, keep records and sample suspect feed.

Go deeper on this site

- Ch 7. Drug use in poultry and aquaculture (in this book)
- Ch 5. Nutraceuticals, herbal and ethnoveterinary medicine (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Concepts
- Veterinary Drug Concepts Clearly Explained

Sources

- WHO: Antimicrobial resistance fact sheet
- WHO: One Health
- WOAH: Codes and Manuals

CHAPTER 7 OF 7

Drug use in poultry and aquaculture

Why treating a flock or a pond differs from treating one animal: group dosing, water and feed medication, the practical limits of each route, withdrawal for eggs, meat and fish, and the main rules and cautions for fish and shrimp medicines.

After this chapter you can

- Explain the logic of flock-level treatment and its limits
- Describe how water and feed medication work and what can make them fail
- Apply withdrawal logic to broilers, layers, fish and shrimp
- Explain why temperature, water quality and the environment matter for aquatic drug use
- Advise a farmer on prudent drug use and banned substances, hedging current Indian rules

Treating a flock or a pond is a population problem

In a poultry house or a fish pond you almost never treat a single animal. The patient is the whole group, and the drug must reach every animal through feed or water. This changes the thinking in four ways.

- Treatment is **delayed** because disease is usually noticed late, after many animals are already affected.
- Dose is only as good as **intake**. A sick bird or fish eats and drinks less, so the animals that most need the drug get the least.
- Cost, labour and the long list of withdrawal obligations force you to be selective.
- The same drug exposure reaches healthy animals, which increases the chance of resistance and residues.

For this reason prevention (biosecurity, vaccination, nutrition, stocking density, water quality) is always the first line, and a drug is a last tool used on a diagnosis.

Submit samples or post-mortem findings, and choose a drug on the basis of the likely cause and sensitivity testing where possible. Avoid treating 'cough' or 'mortality' blindly. Many such problems are viral, parasitic or due to management, and an antibiotic does nothing for them.

Water and feed medication in poultry

Water medication is the usual choice for flock treatment because birds still drink when they stop eating, so water reaches sick birds sooner than feed does. It is also quick to start and stop.

Several things can make water medication fail.

- **Water intake varies** with age, temperature and health. In hot weather birds drink more, so they take more drug; in cold or disease they drink less. The medicine concentration must be set with the expected intake in mind, following the label.
- **Solubility and stability.** A drug that does not dissolve fully, or that breaks down in hard water, in sunlight or in the presence of chlorine or minerals, will not deliver the intended dose. Some drugs bind calcium in hard water.
- **Biofilm and pipes.** Drinker lines may hold biofilm that traps drug and bacteria. Clean lines before and after treatment.
- **Dead ends and uneven flow.** Birds at the far end of the line may get less.
- **Competing water sources.** Make sure the medicated water is the only source, and prepare fresh solutions as the label directs.

Feed medication suits longer programmes, such as coccidiostats, but it is slower to start, depends on appetite and has the carry-over problem discussed in the previous chapter. Mixing must be uniform, and medicated feed must be cleared from lines and bins before another type of feed is made.

Do not use antibiotics together with live bacterial vaccines unless the product information permits it, and do not add disinfectant chlorine to vaccine water. Always follow the product label.

Withdrawal and residues in poultry

Poultry are food animals, and drug residues in meat and eggs are a trade and public-health issue. Withdrawal means that the last dose must be given long

enough before slaughter or egg collection for residues to fall to acceptable levels.

Broilers are slaughtered young, so the margin between treatment and slaughter is short. A treatment started late in a short cycle may run into the slaughter date. Plan the timing and consider whether the batch should be held.

Layers. Many antimicrobials are not permitted for use in birds producing eggs for human consumption, and eggs can carry residues. Check the label and the current rules. If a drug must be used in a laying flock for a good reason, the eggs have to be kept out of the food chain for the required time.

Extra-label and unregistered use. If a product has no stated withdrawal time for the species, do not assume that it is zero.

Banned substances. Some compounds, such as nitrofurans and chloramphenicol, are prohibited in food animals in many countries, including India, and no withdrawal time makes them acceptable. Action on colistin in food animals has also been taken in India. Check the current notifications for the complete and updated list.

Always keep a treatment record: product, batch, dates, quantity, house and who gave it. The record protects the farmer and allows traceback.

Aquaculture: why fish are different

Fish and shrimp live *in* the medium that carries the drug, which makes aquaculture different from land-based farming.

- **Temperature rules the pharmacokinetics.** Fish and shrimp are cold-blooded, so absorption, metabolism and excretion all vary with water temperature. A drug cleared in a few days in warm water may take far longer in cool water. Withdrawal times for fish are therefore commonly expressed in **degree-days**, a combination of days and temperature.
- **Routes.** Medicated feed is the main route for systemic treatment. Bath or dip treatments are used for external parasites and skin infections. Injection is used for valuable broodstock and individual fish.
- **Feed intake falls in disease.** As in poultry, sick fish stop eating, so oral medication fails exactly when it is most needed. Uneaten medicated pellets also leach drug into the water.

- **The environment is part of the treatment.** Drugs and disinfectants may kill beneficial microbes in biofilters and ponds, reduce dissolved oxygen, or harm other organisms. Antimicrobial residues in pond water and sediment select for resistant bacteria and can spread beyond the farm.
- **Water quality comes first.** Low oxygen, poor pH, ammonia and crowding cause stress and disease, and correcting them often does more than any drug. Treat the water before the fish.

Medicines used for baths and dips can be dangerous if the concentration, contact time or aeration is wrong, because fish have small safety margins and gill damage is quick. Follow expert advice and the label.

Fish and shrimp medicines and the rules (hedged)

Few drugs are formally approved for use in aquatic species in any country, and approval differs between countries. A veterinarian or aquaculture expert should choose what is used.

The general principles are the same as for poultry. Use drugs only for a diagnosed problem, choose the narrowest effective option, and respect withdrawal times. Probiotics, good feed, vaccines where available and water management are the preferred first measures.

Rules in India. Aquaculture in India is subject to rules on the use of antibiotics and other pharmacologically active substances, with regulation of coastal aquaculture and export residue monitoring. Several substances, including certain antibiotics and dyes such as malachite green, are prohibited in aquaculture in many exporting countries, and shrimp consignments with banned residues may be rejected abroad. The exact list of prohibited and permitted substances and the responsible agencies change, so check the current notification of the relevant Indian authority and the import rules of the destination market before advising on any drug.

The 'zero tolerance' idea is important. For certain banned compounds, detectable residue is a violation, however small the amount, and no withdrawal time helps.

What to tell the fish or shrimp farmer

Give the farmer a short, practical list.

1. Check water quality first and keep records of oxygen, pH, temperature and mortality.
2. Do not use antibiotics by habit, and do not buy 'secret' mixtures from unknown sellers.
3. Use only approved or veterinarian-advised products, at the labelled concentration.
4. Observe the withdrawal time, remembering that cool water lengthens it.
5. Keep treatment records and batch numbers, and do not harvest early.
6. Dispose of used water and medicated feed responsibly.

Concept cleared

Treat the population, but dose depends on individual intake
In flocks and ponds, the sickest animals eat and drink least, so group dosing under-doses the animals that need it most.

Water first, drug second
Water quality and management are the main drivers of fish and poultry disease and often the best treatment.

Withdrawal protects the food chain
Eggs, meat and fish must be free of residues above accepted limits, and banned substances allow no safe period.

Temperature controls fish pharmacokinetics
Cold-blooded animals clear drugs slowly in cool water, so withdrawal is expressed in degree-days.

Memory aid: Before you medicate a flock or pond: DIAGNOSE-DOSE-DEADLINE
Diagnose the cause, check the dose reaches the animals through intake and water quality, and note the deadline set by withdrawal before sale or harvest.

Compare and contrast

Water medication versus feed medication in poultry

Feature	Water medication	Feed medication
Speed of start	Quick	Slower, needs mixing and delivery
Sick birds	Often still drink	Often stop eating
Main risks	Solubility, hard water, biofilm, variable intake	Uneven mixing, carry-over, appetite
Best use	Short-course treatment of an outbreak	Longer prevention programmes

Poultry versus aquaculture drug use

Feature	Poultry	Fish and shrimp
Body temperature	Constant	Follows water, so affects drug handling
Main routes	Water, feed	Feed, bath, occasional injection
Withdrawal basis	Days	Degree-days or days adjusted for temperature
Environmental concern	Litter and manure residues	Direct release into water and sediment
Special trade issue	Residues in meat and eggs	Banned-substance rejection of exports

Species notes

Broiler chickens

Short production cycle leaves little time for withdrawal. Late treatment can conflict with slaughter dates.

Laying hens

Many antimicrobials are not permitted when eggs go for human food. Check the label and current rules, and keep treated eggs out of the food chain.

Ducks, quail and turkeys

Freshwater fish (carps)

Do not assume poultry products are safe for them. Species sensitivity differs, so use products labelled for the species, particularly ionophores.

Pond-based, with medication mostly through feed and water management. Temperature affects drug clearance.

Shrimp

Antibiotic residues are a major trade concern. Focus on pond management, biosecurity and permitted products, and check current rules.

Clinical pearls

Self-test: 10 questions

1. Why is water medication often preferred for treating a sick flock?

Sick birds usually continue to drink, so the drug reaches them sooner than through feed.

2. Which factor can cause water medication to fail?

Biofilm, poor solubility and mineral binding can reduce the delivered dose.

3. A main problem of medicated feed is

Traces remain in mixers and lines and contaminate later feed.

4. For laying hens producing eggs for human food, you should

Eggs carry residues, and many antimicrobials are not allowed for layers.

5. Why is fish withdrawal often given in degree-days?

Cold-blooded animals clear drugs more slowly in cooler water.

6. Which is true for a banned substance in food animals?

Zero tolerance means that detection itself is a violation.

7. Why do sick fish respond poorly to medicated feed?

Reduced appetite lowers drug intake exactly when needed.

8. What is the first step in managing a disease outbreak in a pond?

Poor water quality often causes or worsens disease.

9. Why can broiler treatment be problematic?

Late treatment may leave too little time for residues to deplete.

10. Which record is most useful after treating a flock?

These details allow traceback and correct withdrawal calculation.

Key points to revise

1. In flocks and ponds, prevention and diagnosis come before drugs.
2. Water medication reaches sick birds sooner than feed medication but depends on intake, solubility and clean lines.
3. Feed medication has carry-over and appetite problems.
4. Layers need special care because eggs are food and many drugs are not permitted.
5. Withdrawal times must be respected, and banned substances are never acceptable.

6. Fish pharmacokinetics depend on water temperature, so withdrawal uses degree-days.
7. Aquaculture drugs enter the environment directly and can select for resistance.
8. Check the current Indian notifications for prohibited substances, permitted products and residue limits.

Go deeper on this site

- Ch 6. Feed additives, growth promoters and ionophores (in this book)
- Ch 5. Nutraceuticals, herbal and ethnoveterinary medicine (in this book)
- Veterinary drugs list: classes, uses and cautions
- Veterinary Drug Concepts
- Veterinary Drug Concepts Clearly Explained

Sources

- WHO: Antimicrobial resistance fact sheet
- WHO: One Health
- WOAH: Codes and Manuals

How to use Book 4: a short discussion

The first three books taught the science: how drugs move, how they act, which drugs suit which organ system and which drugs fight infection. Book 4 is where that science meets daily practice. The seven chapters cover the products and supportive measures that veterinarians use constantly but that rarely get a full lecture: skin, eye and ear preparations, vitamins and minerals, fluid and electrolyte therapy, herbal and ethnoveterinary remedies, feed additives, and medicines for poultry and aquaculture.

Why supportive care deserves a book of its own

Many animals recover because of what is done around the specific drug: correcting dehydration, restoring a mineral balance, relieving an itch so that the skin can heal, keeping an eye moist while an ulcer repairs. Students often underrate this work

because it feels less dramatic than choosing an antibiotic. Experienced clinicians know that a sound fluid plan or a correct nutritional diagnosis often saves more animals than any single medicine.

Topical drugs and the species problem

Skin, eye and ear products look harmless, yet they cause many avoidable problems. A shampoo that is fine for a dog can be harmful to a cat that grooms itself. A steroid eye drop that calms inflammation can worsen a corneal ulcer. The chapters on dermatology and on eye and ear drugs explain how a topical drug is absorbed, where it can go wrong, and which species deserve extra caution.

Nutrition, fluids and herbal remedies

The chapters on vitamins and minerals and on fluid, electrolyte and acid-base therapy are among the most useful for field work. They show how deficiency and excess both cause disease and why correcting a disturbance too fast can be as dangerous as ignoring it. The chapter on nutraceuticals, herbal and ethnoveterinary medicine takes a fair view. Traditional knowledge in India is valuable and widely used by farmers, but a remedy needs to be judged on evidence, safety and possible interactions, and the veterinarian must be able to explain this respectfully to the owner.

Production animals, residues and regulation

The last two chapters deal with feed additives, growth promoters, ionophores, and medicines for poultry and fish. They connect directly to the residue and stewardship ideas from Book 3. Rules on additives, growth promotion and aquaculture drugs change over time and differ between countries, so the book repeatedly asks you to check the current notification instead of memorising a list that may become out of date.

Talking to owners and farmers

Applied therapeutics is also communication. An owner who cannot give eye drops at the right interval, or a farmer who mixes a water medicine the wrong way, will undo a

correct prescription. Each chapter therefore includes practical points about what to explain, what to warn about and when to ask the animal to be seen again. Clear advice about missed doses, storage, stopping rules and withdrawal periods is part of good prescribing, and examiners increasingly test it through case-based questions as well as through direct drug questions.

How to study this book

Read one chapter at a time, take the ten-question test, and then read the Revise points. Use the Compare tables to set similar products side by side, and read the Species notes before an examination, because species differences are a favourite topic for questions. As in the earlier books there are no dose tables; use the product label or a current formulary for doses. This material is written for education and does not replace the judgement of a registered veterinarian.