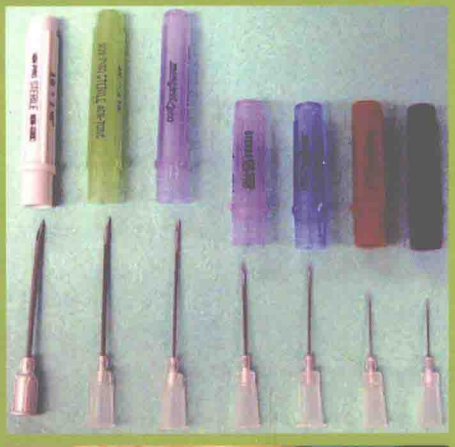
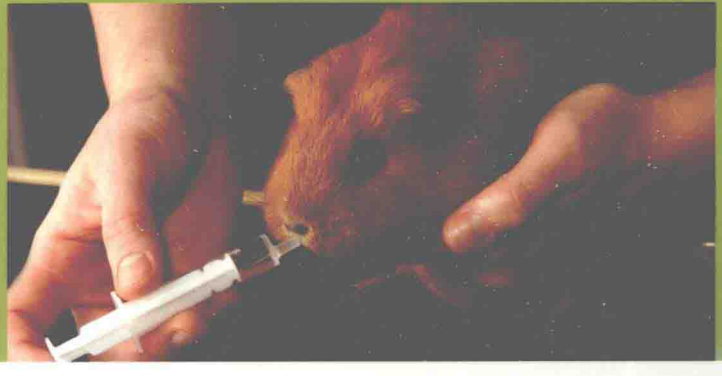
Boyce P. Wanamaker
Kathy Lockett Massey

Applied Pharmacology for Veterinary Technicians

Fifth Edition



ELSEVIER

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ELSEVIER

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SAUNDERS

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This edition is dedicated to
that sense of awe, wonder, and mystery
for nature and the animal kingdom
that inspires us to pursue careers in veterinary medicine
and to recognize the interdependency
of all living things.

B.W.

Thanks to God for the loving miracle of my parents,
Harry and Bettie Lockett, who chose me to share their lives with.

To my children, Eric and Darla, you are the light of my life.
Try to give back to the world more than you take.

To Dr. Wanamaker for his patience.

To Dr. Frankie Locklar for teaching me about tolerance and other life lessons.

To all the technicians and students I've worked with, don't ever forget that we are not just helping animals, but people too. If an animal can make a person laugh, our job may have a twofold purpose.

Perhaps mirth is the epitome of human health.

K.M.

Preface

Applied Pharmacology for Veterinary Technicians, Fifth Edition, is designed for both the graduate technician and the student. As a teaching and reference book, its purpose is to help veterinary technicians become familiar with the many veterinary pharmacologic agents and their uses, adverse side effects, and dosage forms. We believe it is very important for the technician to understand the uses of pharmacologic agents and to have the ability to provide client education under the supervision of the attending veterinarian. One of the key features of this book is that its format provides quick and easy access to important chapter content. Each chapter is introduced with learning objectives, a chapter outline, and key terms. "Technician's Notes" throughout the text provide helpful hints and important points technicians should be aware of to avoid errors and increase efficiency.

NEW TO THIS EDITION

New features have been added to the fifth edition to aid the student and technician in the study and application of pharmacology. All of the drug information throughout the book has been updated and new drugs that have entered the market since the publication of the fourth edition have been included to keep you current with the newest pharmacologic agents and their uses, adverse side effects, and dosage forms. Scientific advances in the area of stem cell treatment have been added to the chapter on immunologic drugs. Coverage of fluid therapy has been expanded to prepare veterinary technicians for the role they play in fluid, electrolyte, and therapeutic nutritional therapy, which can be critically important to the outcome of a case. The fifth edition is now in color, bringing important concepts to life.

EVOLVE SITE

The Evolve student resources offer the following features to reinforce textbook content and help students master key concepts:

- **Drug Administration Videos:** Twelve narrated video clips demonstrate drug administration techniques (oral, injectable, inhaled) and IV preparation for dogs and cats
- **Drug Calculators with Related Exercises:** Six drug calculators with accompanying word problems help students perform accurate drug calculations
- **Drug Label Image Collection:** Over 135 photos of drug labels, divided by chapters and organized alphabetically, help students become familiar with drug information and packaging encountered in practice
- **Animations:** Animations of pharmacologic processes, such as passive diffusion and receptor interaction, help students visualize and understand key concepts
- **Dosage Calculation Exercises:** Exercises reinforce calculations skills and provide valuable practice in the areas of:
  - Drug Calculation Methods
  - Oral and Enteral Medication Administration
  - Intravenous Infusion
  - Critical Care Calculations
- **Answers to Review Questions:** Answers to the chapter review questions allow students to gauge comprehension of key topics

Our intent in writing this book has been to combine the comprehensiveness of a veterinary pharmacology textbook with the coverage of pharmacologic fundamentals needed by veterinary technicians. No longer will veterinary technician educators have to draw from two sources for this type of coverage. The scope and organization of the information in this book will make it a useful reference for the practicing technician as well.

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Kathy Lockett Massey, LVMT

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I would like to acknowledge the editors and staff at Elsevier including Mary Pohlman and Shelly Stringer for their support and assistance in making this edition possible.

I would also like to recognize veterinary technicians and veterinary technology students everywhere whose desire for knowledge and dedication to quality animal care have made animal nursing a true profession.

I would like to thank Columbia State Community College for the opportunities it has provided me.

I would like to acknowledge the following people who have influenced my professional career in a positive way: Charles Byles, DVM; Charles Chamberlain, PhD; Karon Jennings, DVM; Mary Kirby, LVMT; Walter Martin, DVM; Kathy Massey, LVMT; G.M. Merriman, DVM; Christy Pettes, MD; H.B. Smith, DVM; Duane Tallman, DVM; and Dale Thomas, MS.

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Kathy Lockett Massey

Contents

CHAPTER

1

General Pharmacology

KEY TERMS

Adverse drug event
Adverse drug reaction
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Antagonist
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Drug
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Metabolism (biotransformation)
Parenteral
Partition coefficient
Prescription (legend) drug
Regimen
Residue
Veterinarian–client–patient relationship
Withdrawal time

OUTLINE

LEARNING OBJECTIVES

After studying this chapter, you should be able to

1. Define terms related to general pharmacology.
2. List common sources of drugs used in veterinary medicine.
3. Outline the basic principles of pharmacotherapeutics.
4. Define the difference between prescription and over-the-counter drugs.
5. Describe the events that occur after a drug is administered to a patient.
6. List and describe the routes used for administration of drugs.
7. Define *biotransformation*, and list common chemical reactions involved in this process.
8. List the routes of drug excretion.

9. Discuss in basic terms the mechanisms by which drugs produce their effects in the body.
10. Discuss the mechanisms of clinically important drug interactions.
11. Discuss the different names that a particular drug is given.
12. List the items that should be included on a drug label.
13. List the steps and discuss the processes involved in gaining approval for a new drug.
14. List the government agencies involved in the regulation of animal health products.
15. Describe reasons for dispensing rather than prescribing drugs in veterinary medicine.
16. Discuss the primary methods of drug marketing.
17. List acceptable methods of drug disposal.

INTRODUCTION

Veterinary technicians are an essential component of the efficient health care delivery team in veterinary medicine. One of the important tasks that veterinary technicians carry out is administration of **drugs** to animals on the order of a veterinarian. Because this task may have serious consequences in terms of the outcome of a case, it is mandatory that technicians have a thorough knowledge of the types and actions of drugs used in veterinary medicine. They should have an understanding of the reasons for using drugs, called *indications,* and the reasons for not using drugs, called *contraindications* (pharmacotherapeutics). They also should know what happens to drugs once they enter the body (pharmacokinetics), how drugs exert their effects (pharmacodynamics), and how adverse drug reactions manifest themselves (toxicity). Because veterinarians dispense a large number of drugs, technicians also must be well versed in the components of a valid **veterinarian–client–patient relationship,** the importance of proper labeling of dispensed products, and methods of client education on the proper use of products to avoid toxic effects or residue. Finally, technicians should have a basic understanding of the laws that apply to drug use in veterinary medicine and the concept of the marketing of veterinary drugs. In short, veterinary technicians must have a working knowledge of the science of veterinary pharmacology.

DRUG SOURCES

Traditional sources of drugs are plants (botanical) and minerals. Plants have long been a source of drugs. The active components of plants that are useful as drugs include alkaloids, glycosides, gums, resins, and oils. The names of alkaloids usually end in *-ine,* and the names of glycosides end in *-in* (Williams and Baer, 1990). Examples of alkaloids include atropine, caffeine, and nicotine. Digoxin and digitoxin are examples of glycosides. Bacteria and molds (e.g., *Penicillium*) produce many of the antibiotics (penicillin) and anthelmintics (ivermectin) in use today. Animals once were important as a source of hormones such as insulin and as a source of anticoagulants such as heparin. Today, most hormones are synthesized in a laboratory. Mineral sources of drugs include electrolytes (sodium, potassium, and chloride), iron, selenium, and others. Laboratories are one of the most important sources of currently used drugs because chemists are finding methods of reproducing drugs previously obtained through plant and animal sources. Advances in recombinant deoxyribonucleic acid (DNA) technology have

made it possible for animal and human products (e.g., insulin) in bacteria to be produced in large quantities.

INACTIVE INGREDIENTS

Veterinary pharmaceutic products and supplements may contain substances in addition to active ingredients. Inactive ingredients are classified as binders, coatings, coloring agents, disintegrants, emulsifiers, fillers, flavorings, flow agents, humectants, preservatives, sweeteners, and thickeners (Table 1-1).

PHARMACOTHERAPEUTICS

Veterinarians are challenged by the task of assessing a patient to determine a diagnosis and arrive at a plan of treatment. If the plan of treatment includes the use of drugs, the veterinarian must choose an appropriate drug and a drug regimen. The drug is selected through the use of one or more broadly defined methods called *diagnostic, empirical,* or *symptomatic.* The diagnostic method involves assessment of a patient, including a history, physical examination, laboratory tests, and other diagnostic procedures, to

TABLE 1-1 Inactive Ingredients

INACTIVE INGREDIENT	FUNCTION	EXAMPLES
Binder	Holds tablet together	Cellulose, lactose, methylcellulose, sorbitol, starch, xylitol, and others
Coating	Protects tablet from breaking, absorbing moisture, and early disintegration	Beeswax, carob extract, methylcellulose, cellulose acetate, acrylic resin, and others
Coloring agents	Provide color and enhance appearance	Yellow No. 5, annatto, caramel color, titanium oxide, FD&C Blue No. 1, FD&C Red No. 3, and others
Disintegrants	Expand when exposed to liquid, allowing tablets and capsules to dissolve and disperse their active ingredients	Cellulose products, crospovidone, sodium starch glycolate, and starch
Emulsifiers	Allow fat-soluble and water-soluble agents to mix so they do not separate	Stearic acid, xanthan gum, lethicin, and vegetable oils
Fillers/diluents	Increase bulk or volume	Calcium carbonate, calcium sulfate, cellulose lactose, mannitol, sorbitol, starch, sucrose, and vegetable oils
Flavor agents	Create a desired taste or mask an undesirable taste	Beeswax, carob extract, glyceryl triacetate, and natural orange
Flow agents	Prevent powders from sticking together	Calcium stearate, glyceryl triacetate, polyethylene glycol, silica, sodium benzoate, and talc
Humectants	Hold moisture in a product	Glycerin, glycerol, glycerol triacetate, and sorbitol
Preservatives	Prevent degradation and extend the shelf life of a product	Citric acid, glycerol, potassium benzoate, sodium benzoate, and others
Sweetening agents	Improve taste	Aspartate, fructose, glycerin, sorbitol, sucrose, and xylitol
Thickening agents	Increase the viscosity of a product	Methylcellulose, povidone, sorbitol, and others

Adapted from ConsumerLab.com: Review article: inactive ingredients in supplements (website). https://www.consumerlab.com/reviews/Inactive_Ingredients_in_Supplements/inactiveingredients. Accessed July 30, 2013.

arrive at a specific diagnosis. Once the diagnosis has been determined, the causative microorganism or altered physiologic state is revealed to allow selection of the appropriate drug. The empirical method calls on the use of practical experience and common sense when the drug choice is made. In other instances, drugs are chosen to treat the symptoms or signs of a disease if a specific diagnosis cannot be determined. In veterinary medicine, the comparative cost of a drug also may be an important consideration in selection of an appropriate drug. Once the drug to be used in treatment has been decided, the next step for the veterinarian is to design the plan for administering the drug. This plan, called a **regimen**, includes details about the following:

- The route of administration
- The total amount to be given (dose)
- How often the drug is to be given (frequency)
- How long the drug will be given (duration)

Every drug has the potential to cause harmful effects if it is given to the wrong patient or according to the wrong regimen. Some medications have greater potential than others for producing harmful outcomes. According to the U.S. Food and Drug Administration (FDA), when a drug has potential toxic effects or must be administered in a way that requires the services of trained personnel, that drug cannot be approved for animal use except when given under the supervision of a veterinarian. In such a case, the drug is classified as a **prescription drug** and must be labeled with the following statement: "Caution: Federal law restricts the use of this drug to use by or on the order of a licensed veterinarian." This statement sometimes is referred to as the *legend,* and the drug is called a *legend (prescription) drug.* Labels that state "For veterinary use only" or "Sold to veterinarians only" do not designate prescription drugs. Technicians should be aware that prescription drugs often have been approved by the FDA for use in specific species or for particular diseases or conditions. Veterinarians have some discretion to use a drug in ways not indicated by the label, if they take responsibility for the outcome of use. Use of a drug in a way not specified by the label is called **extralabel use.**

Federal law and sound medical practices dictate that prescription drugs should not be dispensed indiscriminately. Before prescription drugs are issued or extralabel use is undertaken, a valid veterinarian–client–patient relationship must exist. For this relationship to occur, several conditions must be met. These include but are not limited to the following:

- The veterinarian has assumed responsibility for making clinical judgments about the health of the animal(s) and the need for treatment, and the client has agreed to follow the veterinarian's instructions.
- The veterinarian has sufficient knowledge of the animal(s) to issue a diagnosis. The veterinarian must have seen the animal recently and must be acquainted with its husbandry.
- The veterinarian must be available for follow-up evaluation of the patient.

Drugs that do not have enough potential to be toxic or that do not require administration in special ways do not require the supervision of a veterinarian for administration. These drugs are called *over-the-counter* drugs because they may be purchased without a prescription. Drugs that have the potential for abuse or dependence have been classified as *controlled substances.* Careful records of the inventory and use of these drugs must be maintained, and some of them must be kept in a locked storage area.

When a drug and its regimen have been selected, veterinary technicians often are directed through verbal or written orders to administer the drug. Technicians have several important responsibilities in carrying out these orders:

1. Ensuring that the correct drug is being administered
2. Administering the drug by the correct route and at the correct time
3. Carefully observing the animal's response to the drug
4. Questioning any medication orders that are not clear
5. Creating and affixing labels to medication containers accurately
6. Explaining administration instructions to clients
7. Recording appropriate information in the medical record

Technicians should be aware that even when the correct drug is administered in a correct manner, an unexpected adverse reaction might occur in a patient. All adverse events or reactions should be reported immediately to the veterinarian.

PHARMACOKINETICS

Pharmacokinetics is the complex sequence of events that occurs after a drug is administered to a patient (Figure 1-1). Once a drug has been given, it is available for absorption into the bloodstream and delivery to the site where it will exert its action. After a drug is absorbed, it is distributed to various fluids and tissues in the body. It is not enough, however, for the drug simply to reach the desired area. It also must accumulate in that fluid or tissue at the required concentration to be effective. Because the body immediately begins to break down and excrete the drug, the amount available to the target tissue becomes less and less over time. The veterinarian then must administer the drug repeatedly and at fixed time intervals to maintain the drug at the site of action in the desired concentration. Some drugs are administered at a high dose (loading dose) until an appropriate blood level is reached. Then the dose is reduced to an amount that replaces the amount lost through elimination. Doses of other drugs are at the replacement level throughout the regimen. The point at which drug accumulation equals drug elimination is called the *steady state* or *distribution equilibrium.* This equilibrium represents the state where the amount of drug leaving the plasma for tissue equals the amount of drug leaving the tissue for the plasma. Underdosing leads to less-than-effective levels in tissue, and overdosing may result in toxic levels (Figure 1-2). Drug levels can be measured in blood, urine, cerebrospinal fluid, and other appropriate body fluids to help a veterinarian determine whether an appropriate level has been achieved. This procedure, which is called *therapeutic drug monitoring,* is being used increasingly in

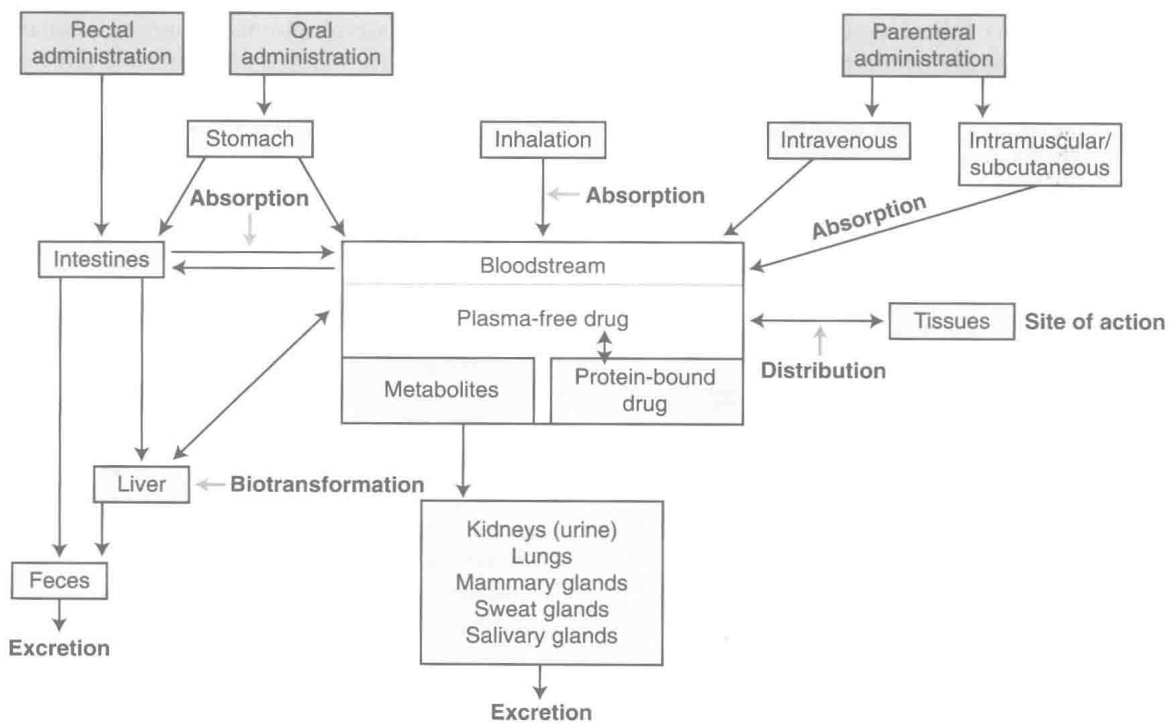

FIGURE 1-1 Diagram of the possible sequence of events that a drug may follow in an animal's body.