Pharmacology/Analgesia

Types of Drugs

Prescriptions and Dispensing Medication

Prescription

- Is an order from a licensed veterinarian directing a pharmacist to prepare a drug for use in a client's animal.

Over the Counter (OTC)

- Do not require a prescription
  - Tylenol

Prescription drugs

Guidelines

- Veterinary prescription drugs must be used only by or on the order of a licensed veterinarian
- A valid veterinarian-client-patient relationship
- Meet proper labeling requirements
- Veterinary prescription drugs should be dispensed only in a quantity necessary for treatment
- Records
- Appropriately handled

Veterinarian-Client-Patient Relationship

- The veterinarian has assumed the responsibility for making clinical judgments regarding the health of the patient and the client has agreed to follow the veterinarians' instructions.
- The veterinarian has sufficient knowledge of the patient to initiate at least a general or preliminary diagnosis of the medical condition of the patient.

Veterinarian-Client-Patient Relationship

- The veterinarian is readily available for follow-up evaluation or has arranged for the following: veterinary emergency coverage, and continuing care and treatment.
- The veterinarian provides oversight of treatment, compliance, and outcome.
- Patient records are maintained.

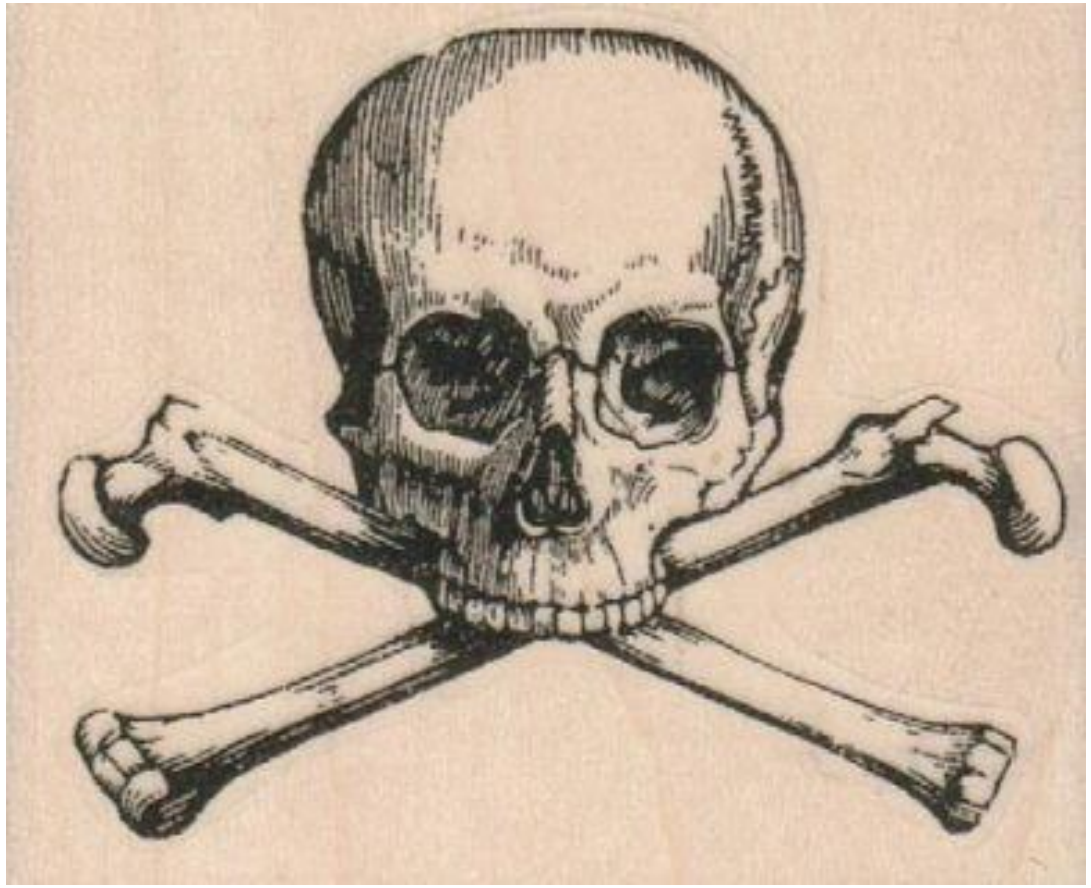
Storing and Prescribing Controlled Substances

- Controlled substance is defined by law as a substance with potential for physical addiction, psychological addiction, and/or abuse.
- Controlled substances must be stored securely under lock and key to prevent access by unauthorized personnel.
- By law, a written record must be kept describing when, for what purpose, and how much of the controlled substance was used.
  - Client last name
  - Patient name
  - Amount utilized
  - Running total
  - Technician initials

Controlled drugs

C-1

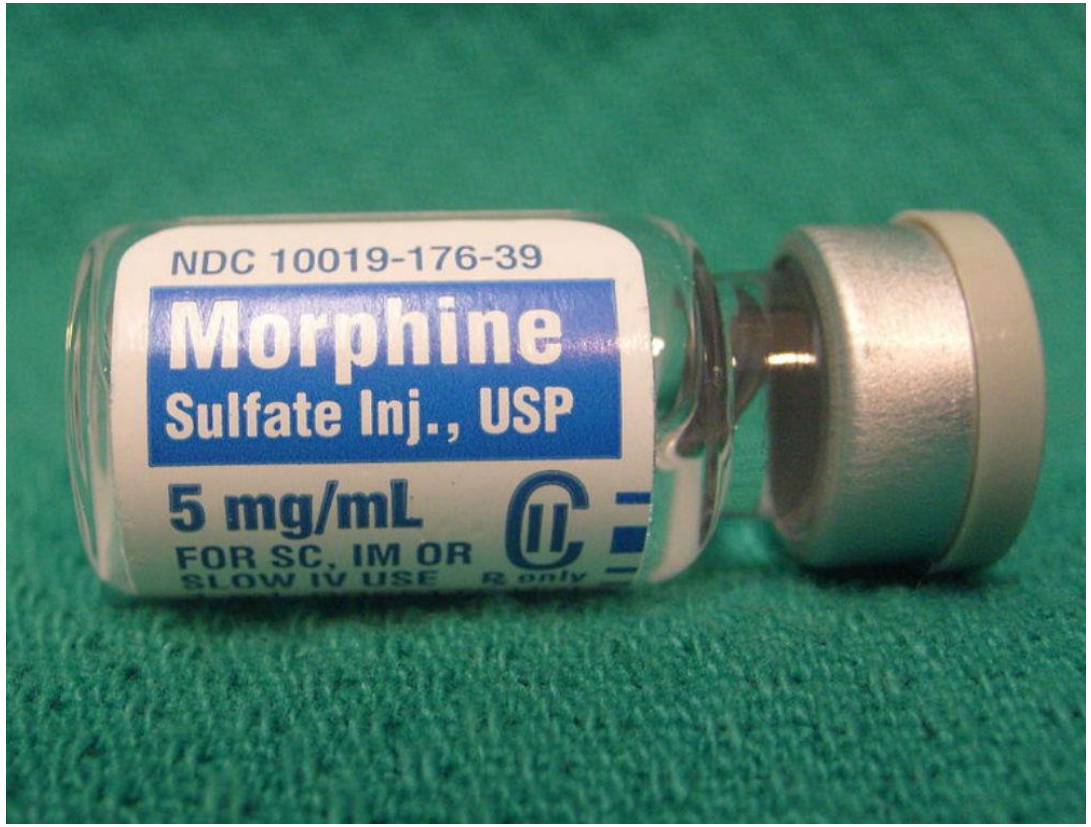
- Extreme potential for abuse with no approved medicinal purpose in the US
  - Heroin
  - LSD



Controlled drugs

C-II

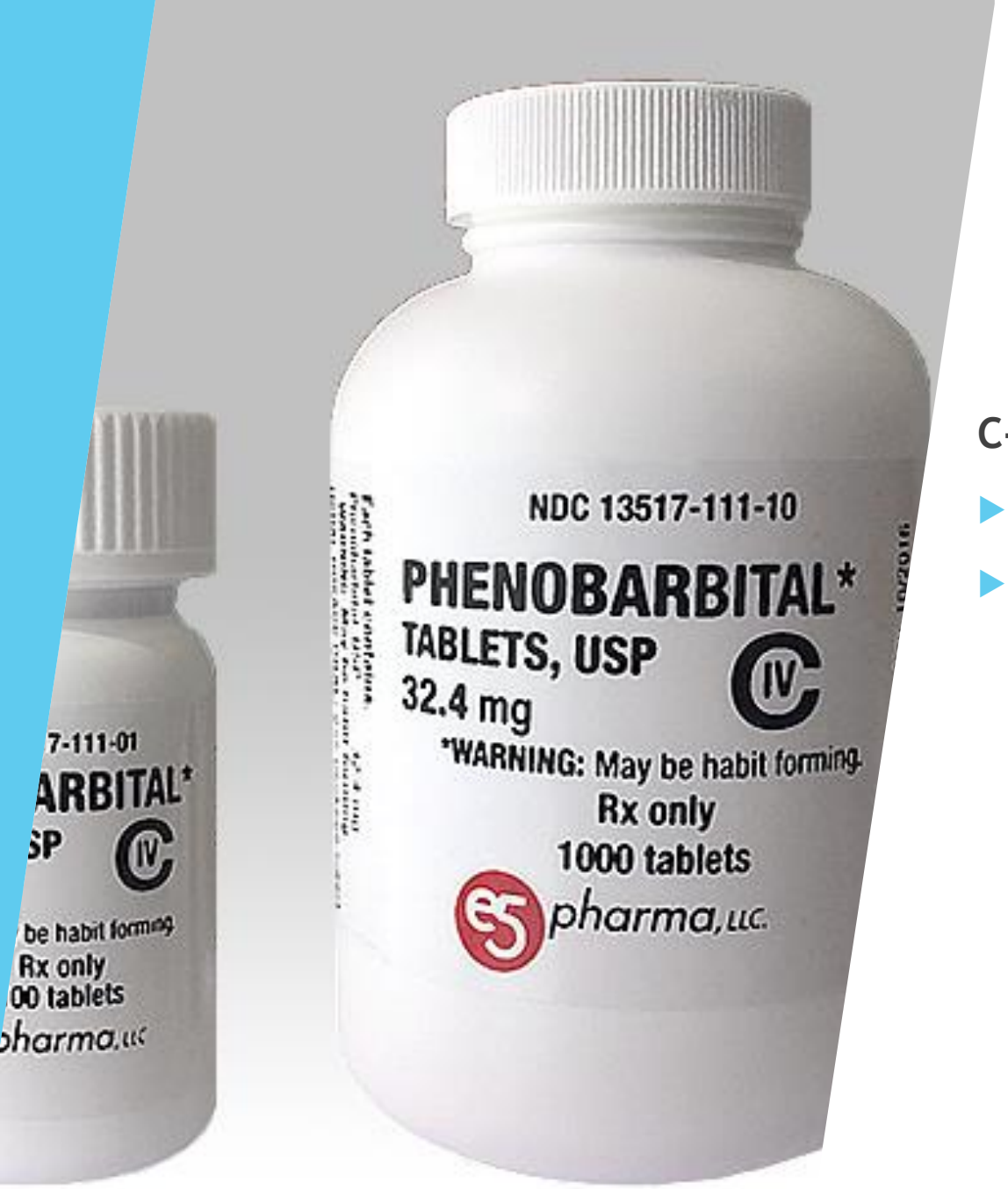
- Denotes a high potential for abuse
- Use may lead to severe physical or psychological dependence
  - Morphine
  - Hydromorphone
  - Fentanyl



Controlled drugs

C-III

- Denotes some potential for abuse but less than C-II drugs
- Use may lead to low to moderate physical dependence or high psychological dependence
  - Ketamine
  - Buprenex



Controlled drugs

C-IV

- Low potential for abuse
- Use may lead to limited physical psychological dependence
  - Phenobarbital
  - Valium

Controlled drugs

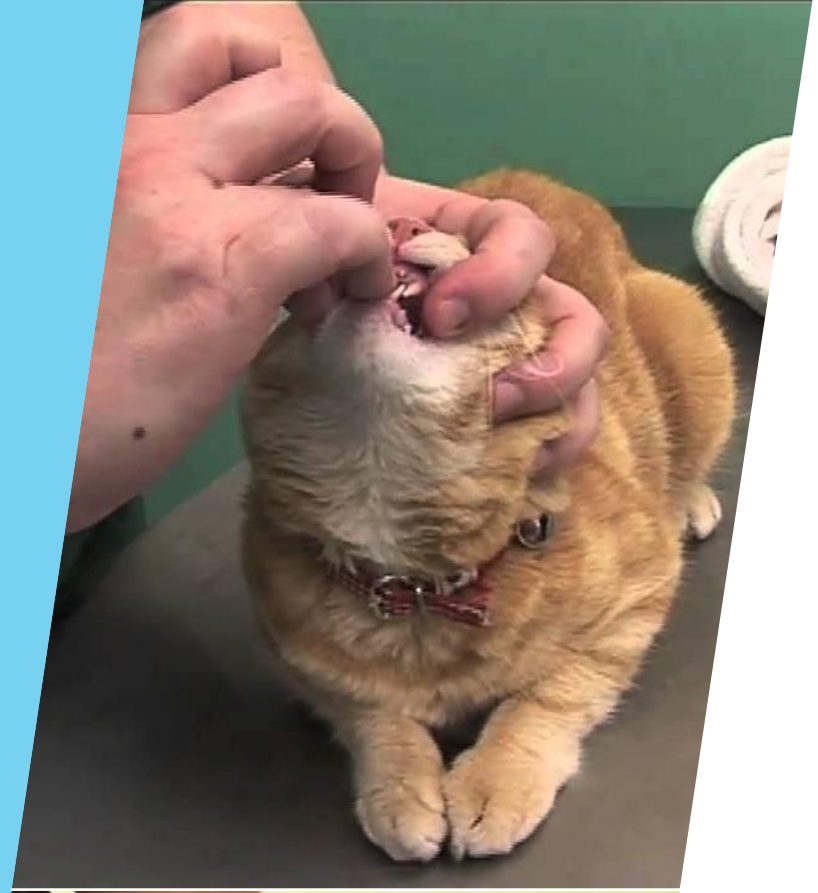
C-V

- Low potential for abuse
- These drugs are subject to state and local regulations
  - Robitussin AC (codeine)

Controlled drugs

- For veterinarians to use, prescribe, or buy a controlled substance legally from an approved manufacturer, they must have obtained a certification number from the DEA
- DEA number must be included on all prescriptions or any order forms
- Even with a valid DEA number, veterinarians CANNOT prescribe C-I drugs

Drug Administration



Routes of Administration

- PO-per os (by mouth)
  - Tablet
  - Capsule
  - Liquid
- Risks
  - Aspiration pneumonia

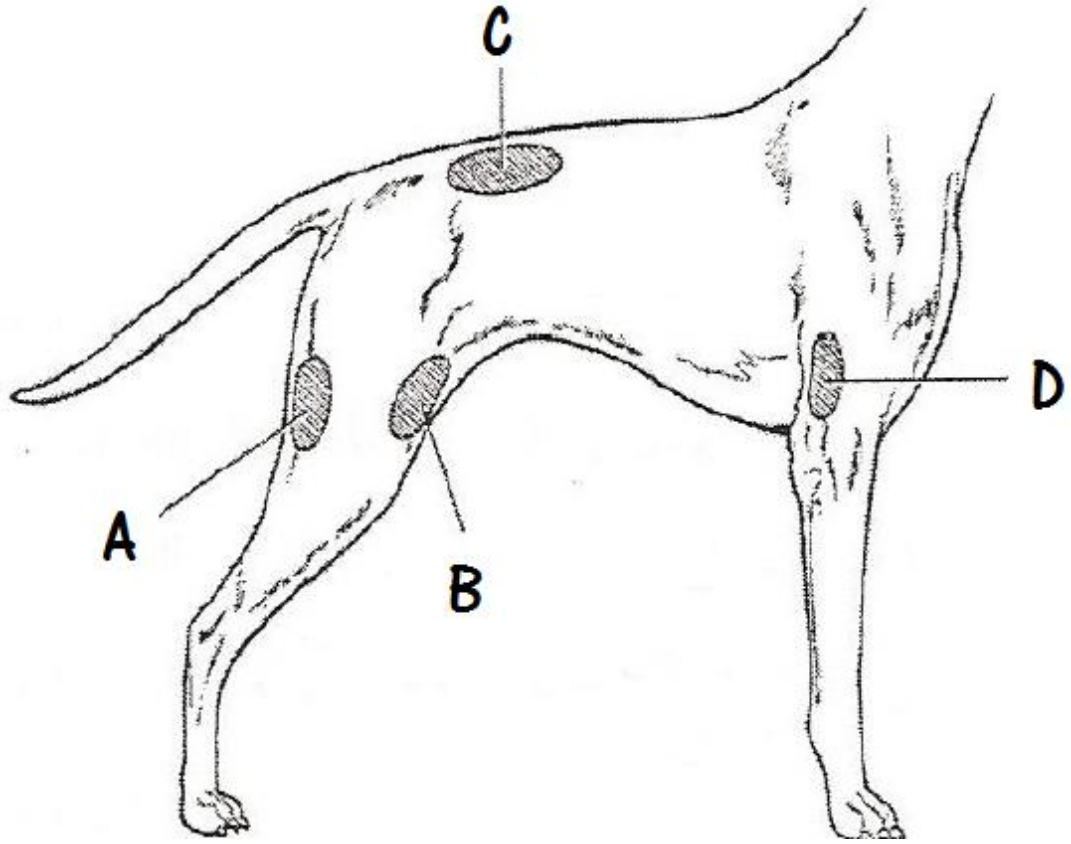
Routes of Administration

IM injections

- Administer medications directly into the muscle
  - Semimembranosus, semitendinosus, middle gluteal (A)
  - Quadriceps (B)
  - Epaxial (C)
  - Triceps (D)

WARNING:

- For IM injections, the maximum amount of volume delivered to any one site should **not exceed 2ml in a small dog or a cat, or 5ml in a medium to large-sized dog**



Route of Administration

Subcutaneous

- Vaccinations
- Subq fluids

Route of Administration

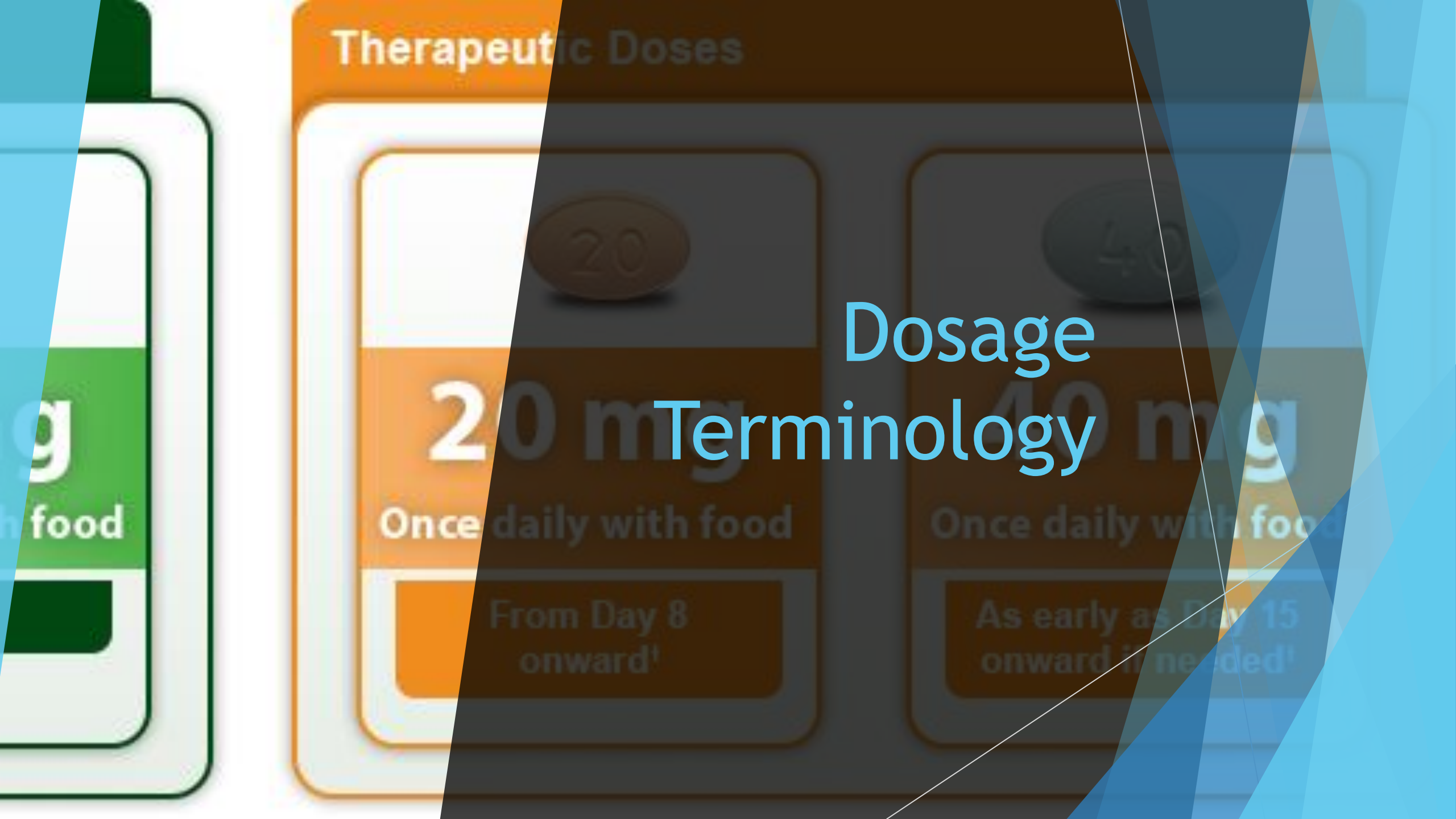
Intravenous (IV)

- Can be administered as a single bolus via IV catheter
- Single bolus without IV catheter
- CRI (constant rate of infusion)

Route of Administration

OTM-transmucosal

- OTM routes include buccal and sublingual
- Syringe should be aimed towards the buccal surface
  - Cheek pouch
- Swallowing should not be encouraged
  - The enterohepatic first-pass effect removes 90+% of the drug before it can reach systemic circulation rendering that route impractical



Dosage Terminology

Definition of Terms

- The **dose** is the amount of medication measured
  - mg, mL
- The **dosage** is the amount of medication based on units per weight of the animal
  - 50 mg/kg, 10 mL/kg
- The **concentration** of the drug is calculated by the manufacturer
  - mg/mL, mg/tablet

Definition of Terms

- **Dosage interval** is the frequency of intermittent drug administration, based on the drug's half-life
  - Bid
  - Sid
  - Tid
- **Dosage regimen** is the specific way a therapeutic drug is to be taken
  - Formulation
  - Route of administration
  - Dose
  - Dosing interval
  - Treatment duration

Definition of Terms

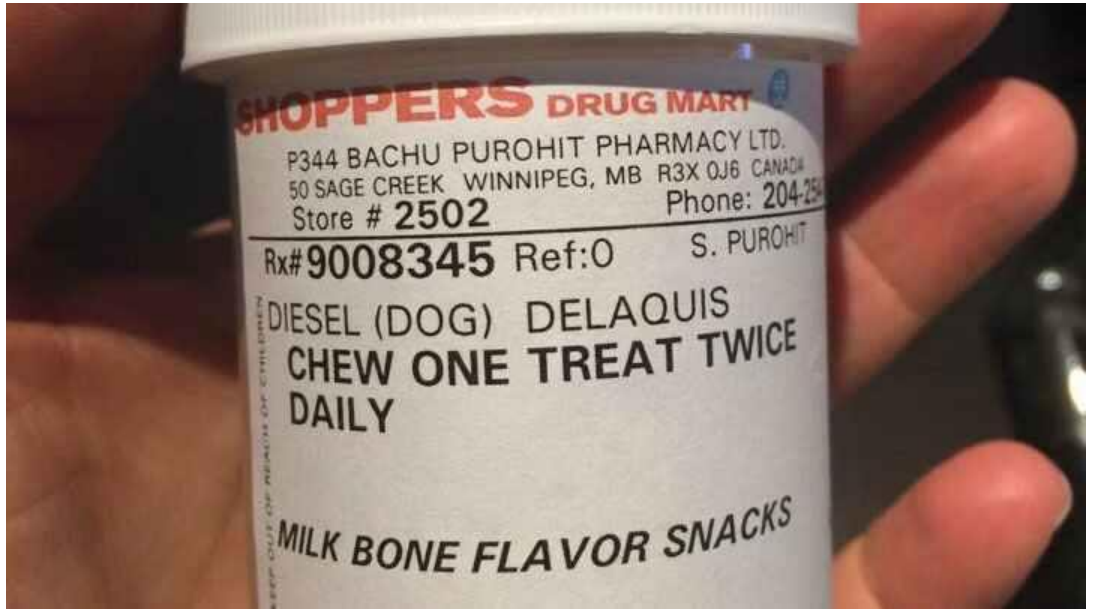
- The **half-life** of a drug is the time it takes for a drug's active substance in your body to reduce by half
- This depends on how the body processes and gets rid of the drug
- It can vary from a few hours to a few days, or sometimes weeks

Drug Names

- Chemical name
  - D-alpha-amino-p-hydroxybenzyl-penicillin trihydrate
  - Describes the drugs chemical composition
- Nonproprietary name (generic name)
  - Amoxicillin
  - Concise name given to the specific chemical compound
  - Most used in the veterinary hospital setting
- Proprietary name
  - BioMox
  - Trade name of the drug
  - Name given by the manufacturer

Prescription Label

- Name, address, and telephone number of prescribing doctor
- Date
- Owner’s name, animal’s name, and species of animal
- Rx symbol
- Drug name, concentration, and number of units to be dispensed
- Directions for administration

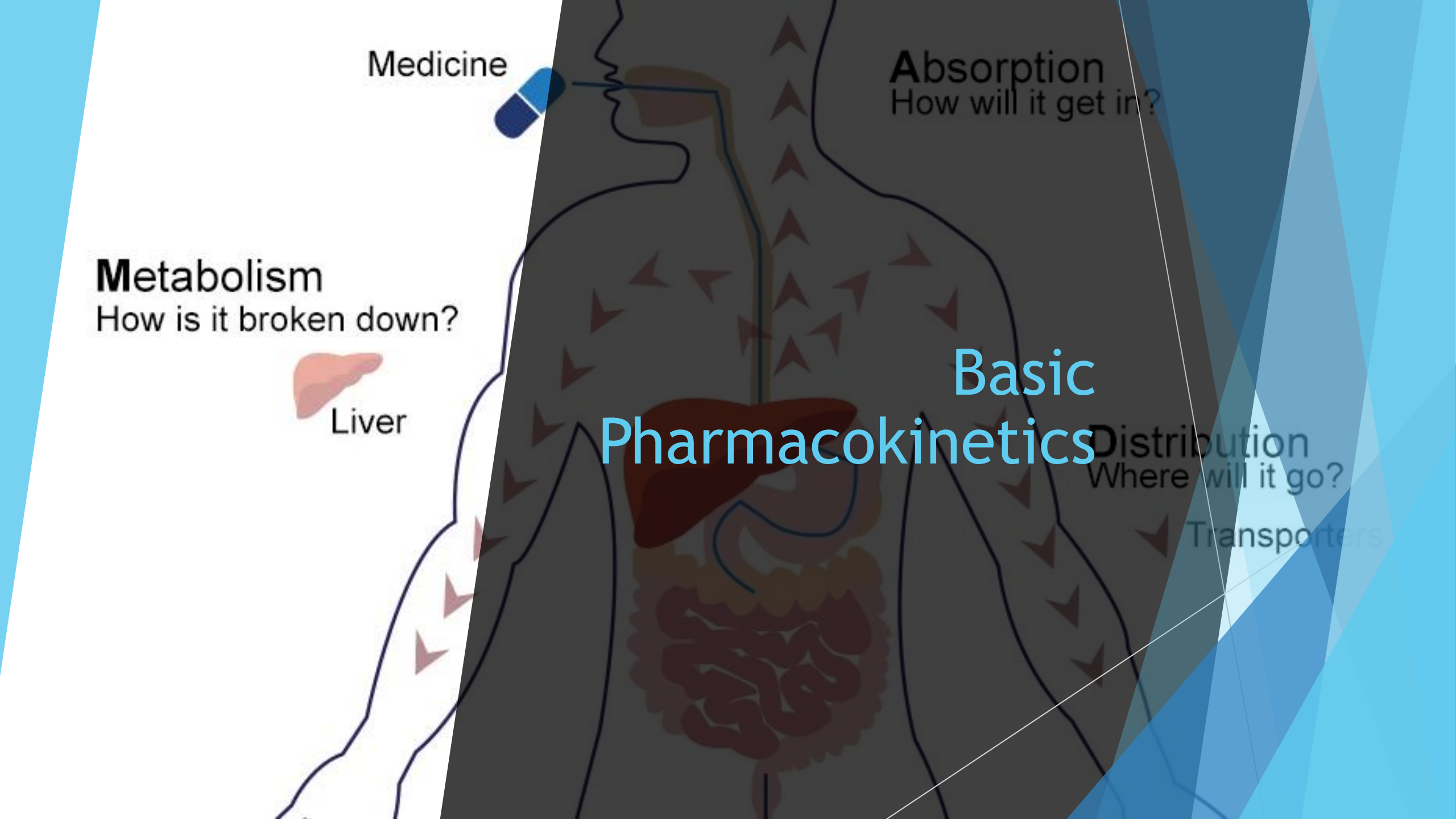


Extra-Label Drug Use

- Extra-label drug use is defined as any use that is different than the labeled use
- To use a drug “on-label” requires that the drug be used in the species for which it is approved, for the indication, by the route, at the dose and for the duration indicated in the labeling
- Any use deviation from this is considered extra-label

Withdrawal Time

- **Withdrawal time** is defined as the time required after administration of a drug to a dairy or meat cow needed to assure that drug residues in the marketable milk or meat, is below a determined maximum residue limit (MRL)



Basic Pharmacokinetics

Pharmacokinetics

- How drugs move into, through, and out of the body
- Knowledge of a drug's pharmacokinetics facilitates understanding of why the drug must be given by different routes or dosage regimens to achieve therapeutic success under different clinical circumstances
- Pharmacokinetics involves
  - Absorption-(how will it get in)
  - Distribution-(where will it go)
  - Metabolism-(how is it broken down)
  - Elimination-(how does it get out)

Pharmacokinetics

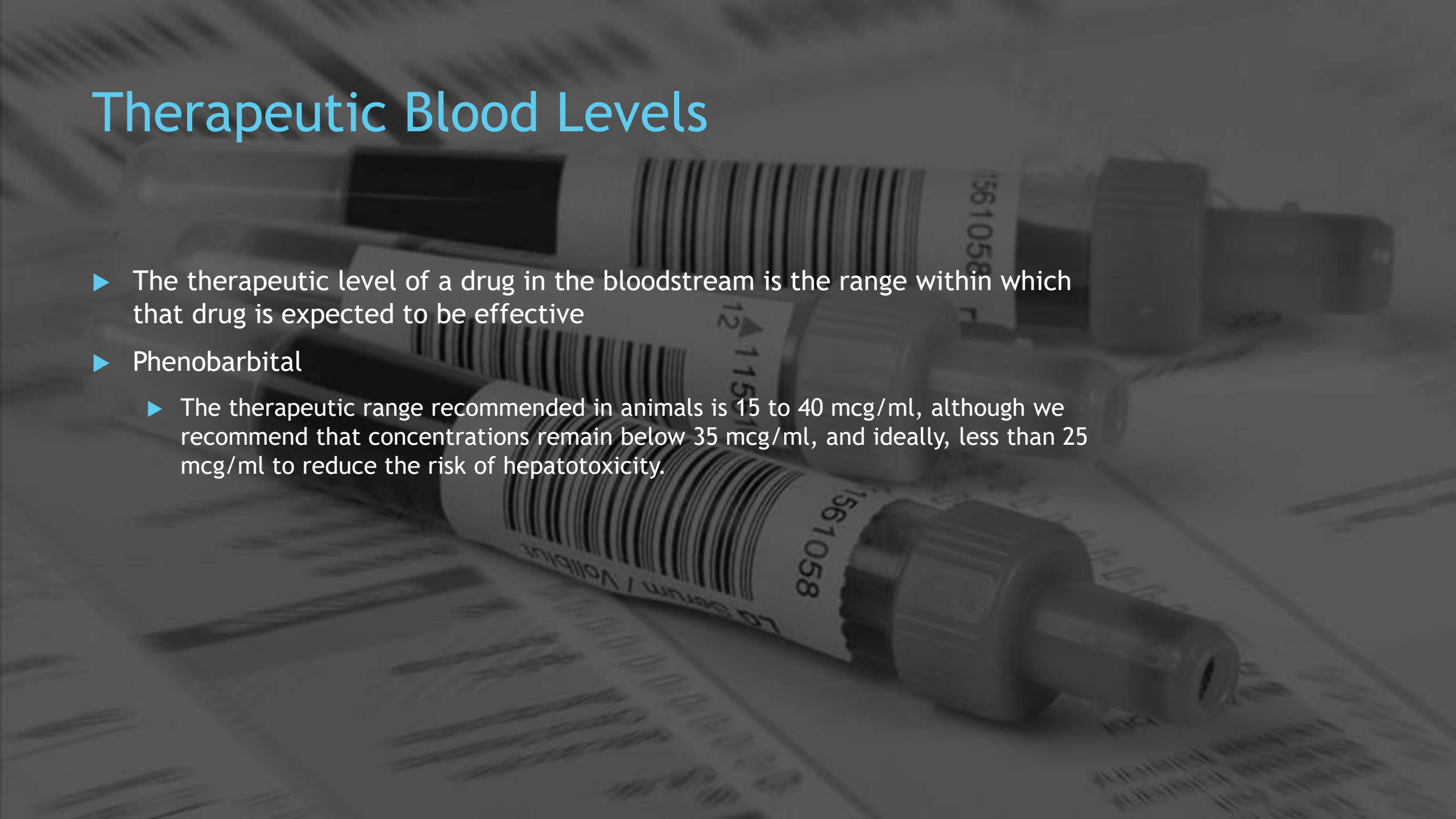
Absorption

- The movement of drug molecules from the site of administration into the systemic circulation
- After a drug has been ingested, injected, inhaled, or applied to the skin, it must be absorbed into the blood and travel to the body areas where it will enact its effect (target tissues)
- **IV injections almost (within 30 seconds) achieve their peak concentration in the blood**
- **IM administration takes some time to diffuse from the injection site (10-15 minutes)**
- **PO administration and SQ injection take the longest (30-45 minutes)**

Lipophilic verses Hydrophilic

- The classification of drugs as hydrophilic or lipophilic depends on their ability to dissolve in water or in lipid-containing media. In this respect, absorption is faster in lipophilic drugs, whereas the ease for renal excretion is greater in hydrophilic medications.

Therapeutic Blood Levels



- The therapeutic level of a drug in the bloodstream is the range within which that drug is expected to be effective
- Phenobarbital
  - The therapeutic range recommended in animals is 15 to 40 mcg/ml, although we recommend that concentrations remain below 35 mcg/ml, and ideally, less than 25 mcg/ml to reduce the risk of hepatotoxicity.

Pharmacokinetics

Distribution

- The movement of a drug from the systemic circulation into tissues
- Drugs generally are distributed most rapidly and in greater concentrations to well-perfused (blood rich) tissues
  - Skeletal muscle
  - Liver
  - Kidney
  - Brain
- Adipose (fat) tissue are relatively poorly perfused, so it takes more time for drugs to be delivered

Pharmacokinetics

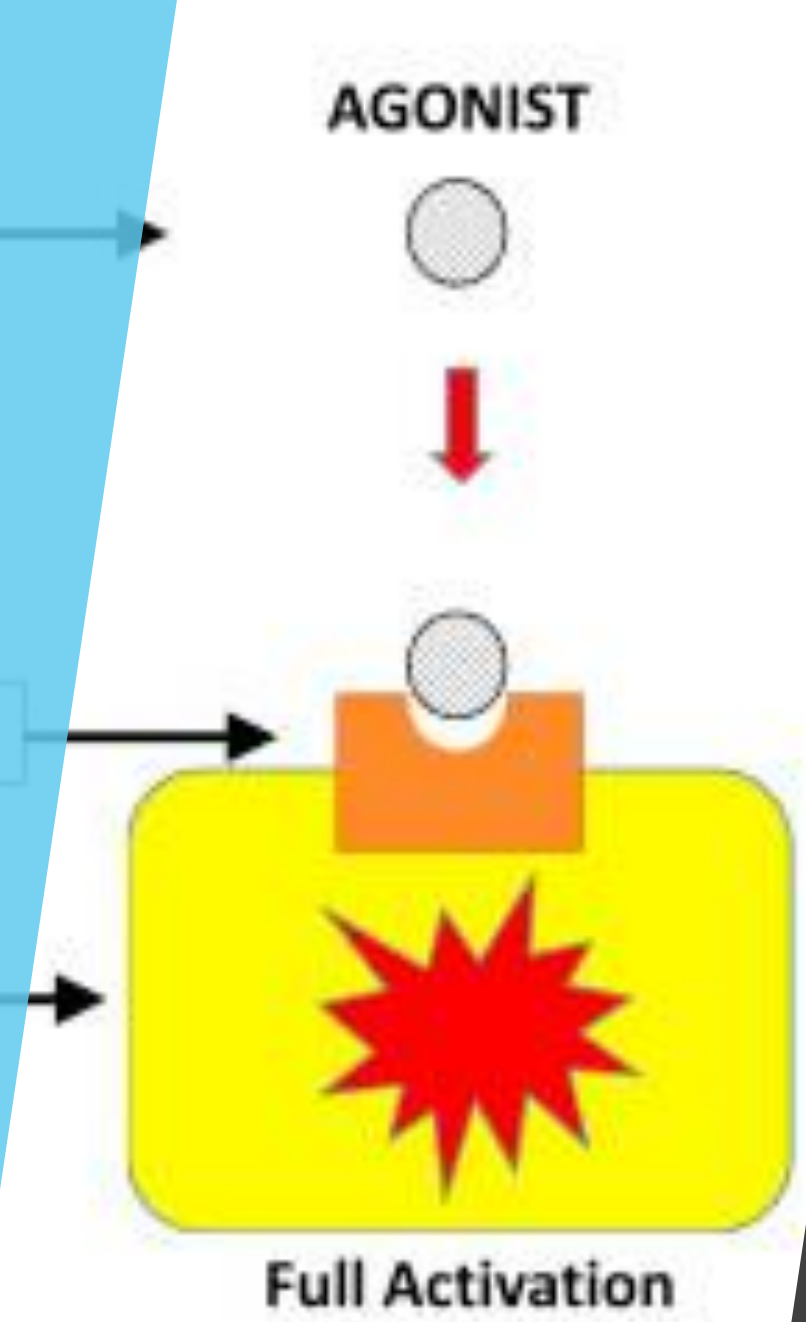
- Many drugs are altered by the body before being eliminated
  - Biotransformation

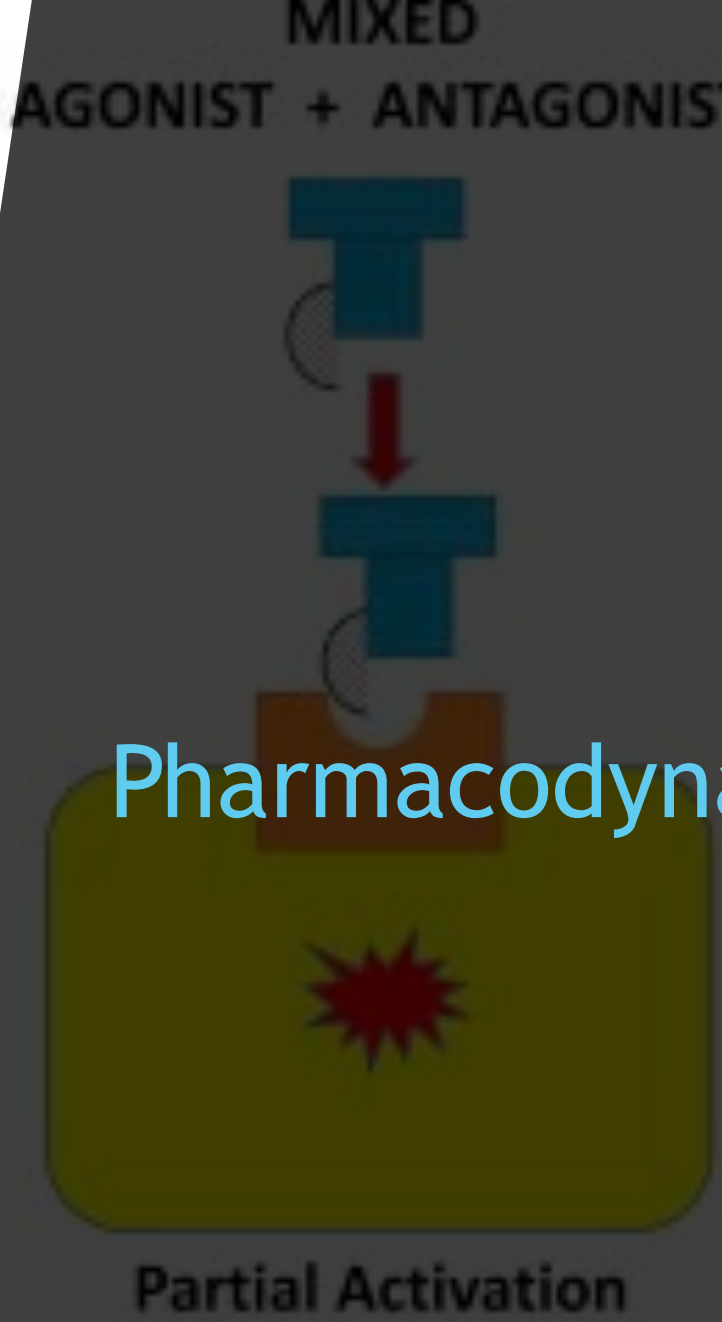
Drug metabolism

- Liver is the primary organ involved in drug metabolism
- Lung, skin, and GI tract may also biotransform drugs
- The ending biotransformed drug is then eliminated via liver or kidney
  - Urine (urine/kidney)
  - Feces (bile/liver)

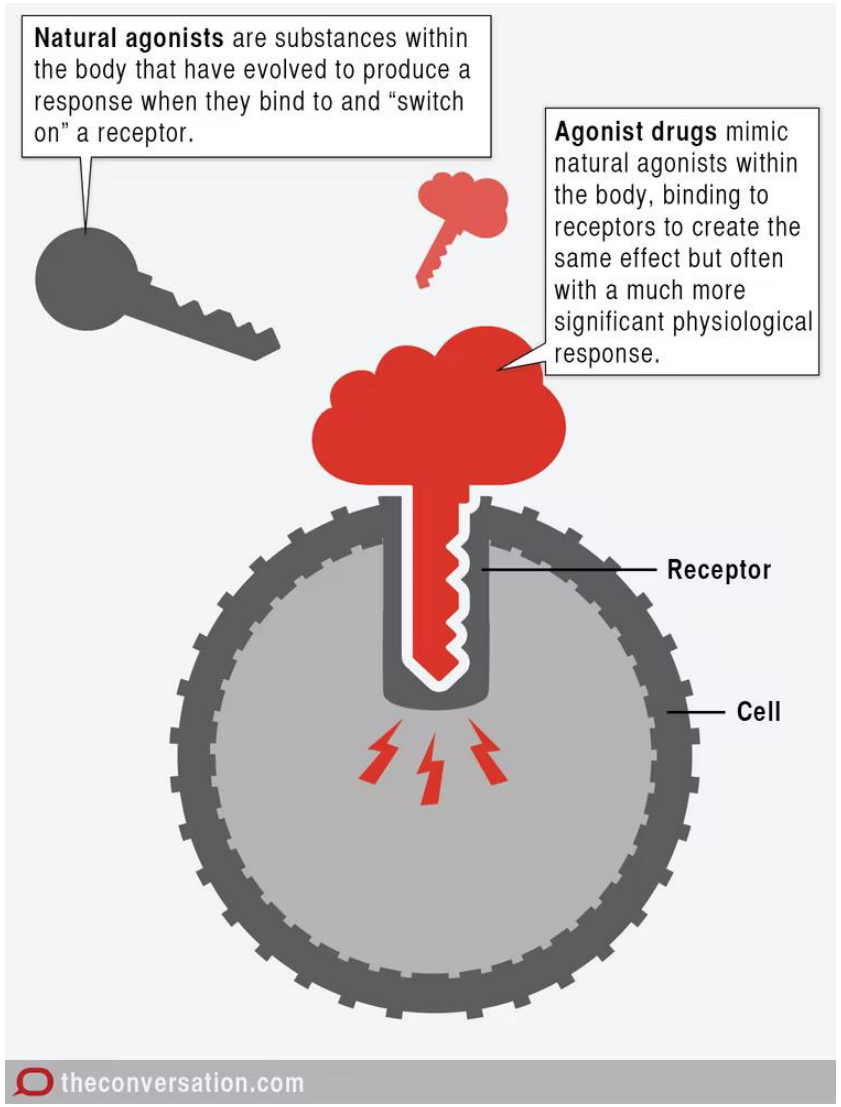
Pharmacokinetics

- Drug elimination is greatly affected by:
  - Dehydration
  - Kidney, liver, or heart disease
  - Age
  - Other physiologic and pathologic (disease) conditions





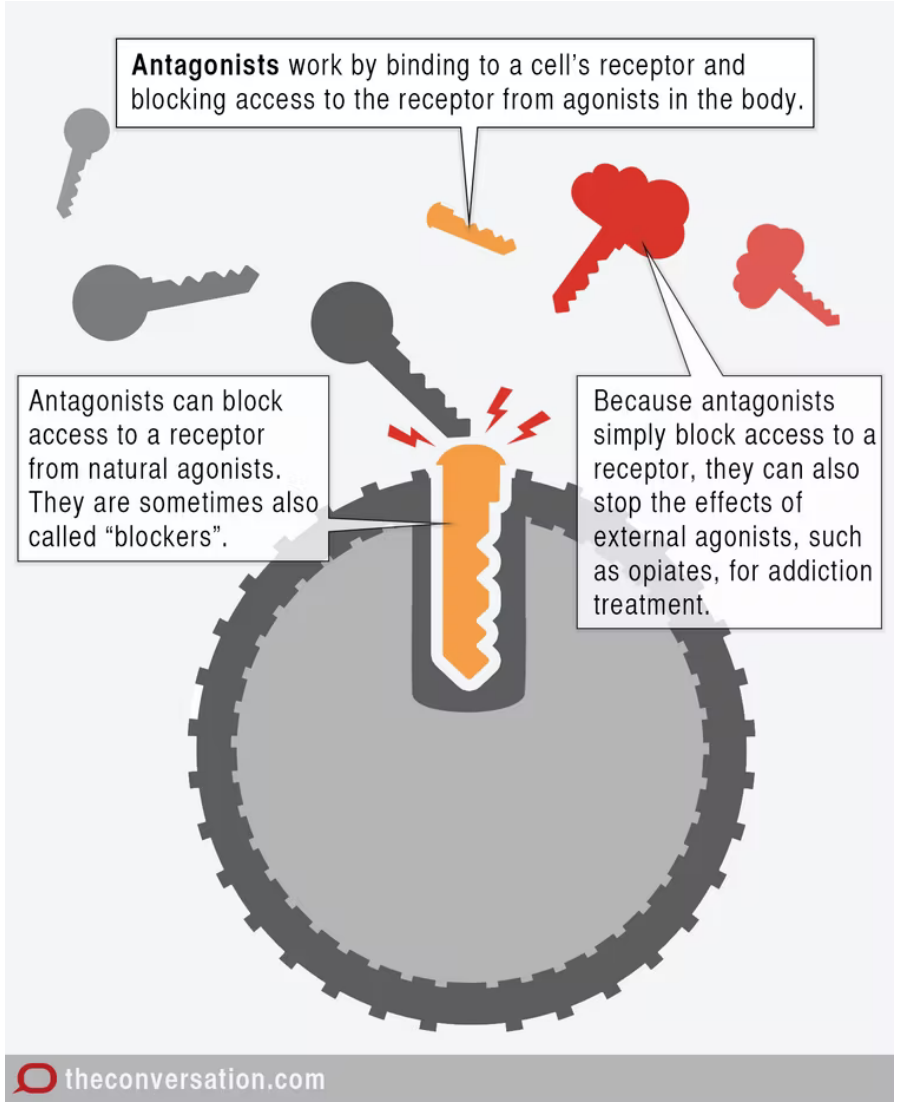
Basic Pharmacodynamics



Mechanism of Action

Agonist

- A drug that binds to the receptor, producing a similar response to the intended chemical and receptor



Mechanism of Action

Antagonist

- Opposite of an agonist
- It binds to receptors, and stops the receptor from producing a desired response

Side Effects and Adverse Drug Reactions

Dose Dependent Drug Reactions

- Reactions that are the result of augmented effects of the usual pharmacological action of the drug and therefore thought to be dose related, predictable and preventable reactions
  - NyQuil causes drowsiness

Idiosyncratic Drug Reactions

- 'Bizarre or idiosyncratic' ADRs are reactions which are less dependent on drug dose and unpredictable based on the pharmacological action of the drug
  - RARE side effects
    - Famotidine causing seizures

Impact of Disease on Drug Pharmacokinetics

Cardiovascular Disease

- Alters distribution of blood flow to tissues
  - More blood is distributed to the brain and heart
    - Increasing the risk for toxicity to these organs
- Alterations in GI, hepatic, and renal blood flow
  - Affects all pharmacokinetics
    - Increases the risk of ADR or drug interactions

Liver Disease

- Primary site for drug metabolism
- Liver houses the metabolic enzymes that convert lipophilic drugs to more water-soluble metabolites for elimination by the kidneys
- Dosage adjustments should be considered if liver disease/failure is present
  - Metronidazole
  - Benzodiazepines
  - Chloramphenicol

Impact of Disease on Drug Pharmacokinetics

Kidney Disease

- Major organ involved in drug elimination
- Decrease drug elimination; increasing plasma drug concentrations
  - Increase risk for ADR and toxicity
  - Consider dose adjustments for drugs excreted through the kidneys
    - Fluroquinolones
    - Aminoglycosides
    - Enalapril
    - Chloramphenicol (cats)
- Dose adjustments also may be necessary for drugs that have an increased risk of side effects
  - Cephalosporins
  - Sulfonamides
  - Tetracycline
  - Furosemide
  - Cimetidine
  - Metoclopramide
  - NSAIDS

Impact of Disease on Drug Pharmacokinetics

Kidney Disease

- Kidneys also play a role in maintaining fluid and electrolyte balance
  - Increased fluid retention can alter the volume of distribution
    - Penicillins
    - Cephalosporins
    - Aminoglycosides

Aging and Drug Pharmacokinetics

- Normal aging changes body composition
  - Decreased lean body mass
  - Decreased total body water
  - Increased fatty tissue
  - Redistribution of blood flow to the brain and heart
    - Decreased cardiac output
- Altered distribution of tissues and blood influences distribution of drugs
- Additional changes include
  - Decreased drug absorption from the GI tract
  - Decreased hepatic metabolism
  - Decreased renal excretion
    - Most clinically significant impact on drug elimination

Antimicrobial Drugs

Antimicrobials

- Drugs that kill or inhibit the growth of microorganisms or microbes, such as bacteria, protozoa, viruses, or fungi
- The suffix –cidal generally describes drugs that kill the microorganism
  - Bactericidal
- The suffix –static describes drugs that inhibit replication but generally do not kill the microorganism outright
  - Fungistatic

Antimicrobials

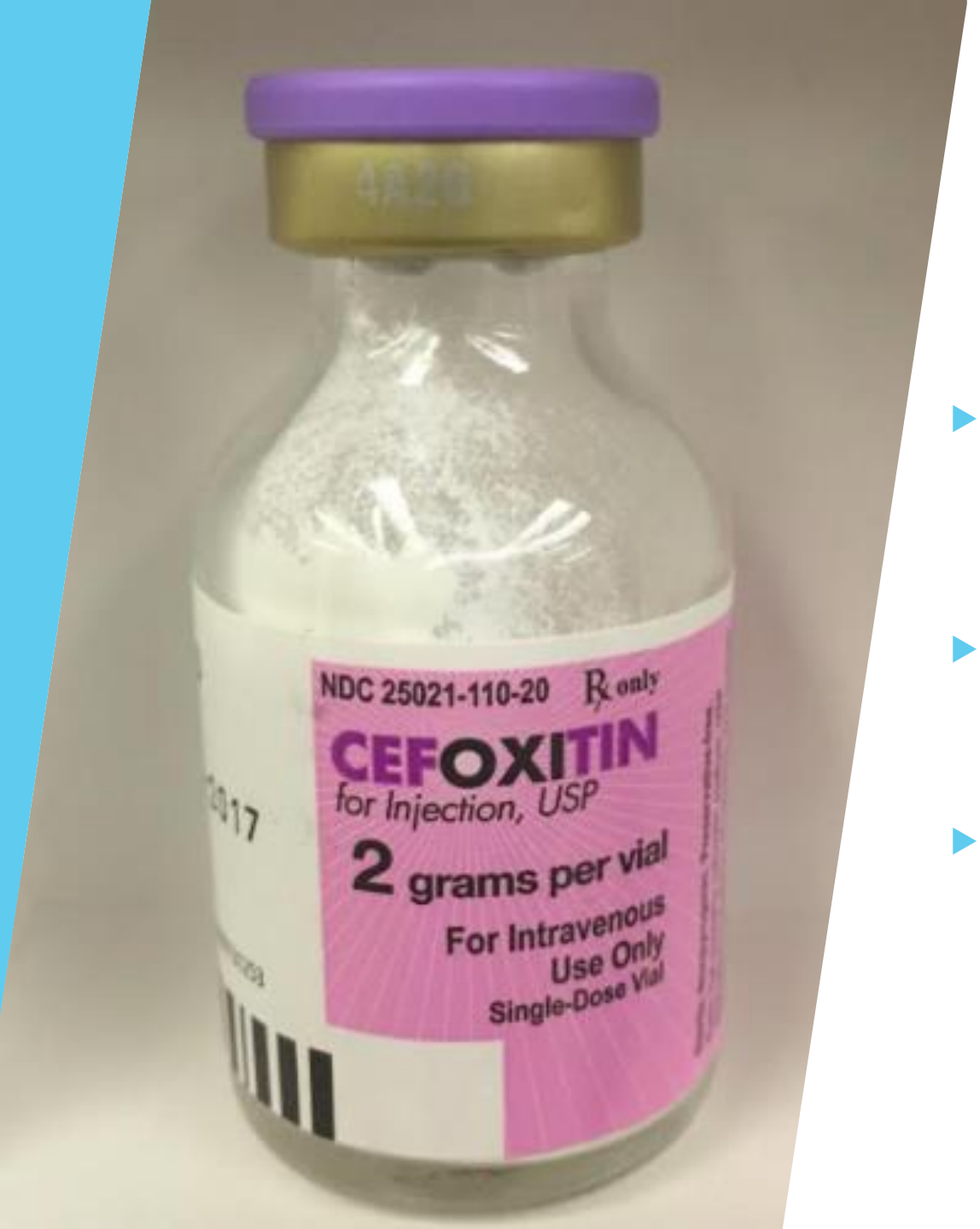
- Bactericidal=kills bacteria
- Bacteriostatic= inhibits bacterial replication
- Virucidal= kills viruses
- Protozoastatic = inhibits protozoal replication
- Fungicidial= kills fungi

Penicillins

- Bactericidal
  - Gram-positive aerobes
  - Obligate anaerobes
- Can be recognized by their –cillin suffix on the drug name
- Most common
  - Ampicillin
  - Amoxicillin
  - Cloxacillin
  - Amoxicillin-clavulanate acid (Clavamox)
- Uses include:
  - Urinary tract
  - Soft tissue
  - Respiratory infections
  - Skin infections
- Caution
  - Diarrhea
  - Hypersensitivity reactions

Cephalosporins-*First Generation*

- Bactericidal
  - Gram-positive aerobes
  - Penicillinase-producing *Staphylococcus*
- Recognized with a ceph- or cef- prefix in the drug name
- Most common include:
  - Cephalexin
  - Cefazolin
  - Cefadroxil
- Uses:
  - Skin infections
  - Orthopedic infections
  - Soft tissue infections
- Caution
  - Diarrhea
  - Vomiting
  - Anorexia
  - Hypersensitivity reactions



Cephalosporins- *Second Generation*

- Bactericidal
  - More gram-negative efficacy than 1st generation
  - Less gram-positive efficacy
- Most common include:
  - Cefotetan
  - Cefoxitin
- Uses:
  - Skin infections
  - Orthopedic infections
  - Soft tissue infections

Cephalosporins- *Third Generation*

- Bactericidal
  - Evan more gram-negative efficacy
  - Significantly less gram-positive efficacy
- Most common include:
  - Cefotaxime
  - Cefpodoxime
  - Ceftiofur
  - Cefovecin
- Uses:
  - Skin infections
  - Orthopedic infections
  - Soft tissue infections

Aminoglycosides

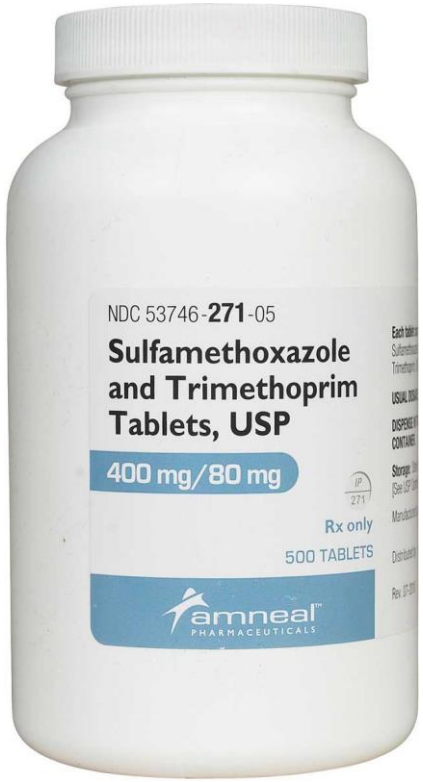
- Bactericidal
  - Gram-negative aerobes
- Recognized by the –micin or mycin- suffix in the nonproprietary name
- Most common:
  - Amikacin
  - Gentamicin
  - Neomycin
  - Tobramycin
- Caution
  - Potentially nephrotoxic and ototoxic even at normal dosages

Sulfonamides-*Unpotentiated*

- Bacteriostatic
  - Gram-positive aerobes
  - Gram-negative aerobes
  - Some protozoa
- Recognized by the –sulfa prefix in the nonproprietary name
- Most common
  - Sulfadiazine
  - Sulfamethoxazole
  - Sulfadimethoxine
- Caution
  - Diarrhea
  - Bone marrow suppression
  - Hypersensitivity reactions in dogs involving joints, bone marrow, skin, liver, and dry eye
  - Teratogenic

Sulfonamides-*Potentiated*

- Bacteriostatic
  - Gram-positive aerobes
  - Gram-negative aerobes
  - Some protozoa
- Recognized by the –sulfa prefix in the nonproprietary name
- Most common
  - Sulfadiazine + trimethoprim
  - Sulfamethoxazole + trimethoprim
  - Sulfadimethoxine + trimethoprim



Fluoroquinolones

- Bactericidal
  - Gram negative aerobes
  - *Brucella, Chlamydia, Mycobacterium, Mycoplasma, Rickettsia*
- Recognized by the –floxacin suffix in the drugs name
- Most common
  - Enrofloxacin (Baytril)
  - Ciprofloxacin
  - Orbifloxacin (Orbax)
  - Marbofloxacin (Zeniquin)
  - Oflaxacin (Ocuflox)
- Uses:
  - Skin
  - Respiratory
  - Urinary infections
- Caution
  - Diarrhea
  - Young animals-cartilage damage
  - Cats-blindness
  - Seizures (with hx of SZ)
  - Do not use in pregnant animals
  - Ciprofloxacin-Do not use in horses

Amphenicols

- Bacteriostatic
  - Gram-positive aerobes
  - Gram-negative aerobes
  - Obligate aerobes
  - *Rickettsia, Chlamydia, mycoplasma*
- Recognized by the –nicol suffix in the drugs name
- Most common
  - Chloramphenicol
  - Florfenciol
- Caution
  - Diarrhea
  - Bone marrow suppression
  - GLOVES to be worn when handling tablets
  - Chloramphenicol ILLEGAL in food producing animals
    - Florfenciol approved for cattle

Tetracyclines

- Bacteriostatic
  - Gram-positive aerobes
  - *Chlamydia, Rickettsia, Borrelia, Mycoplasma*
- Recognized with the –cycline in the suffix
- Most common:
  - Doxycycline
  - Tetracycline
- Caution
  - Diarrhea
  - Esophageal strictures-CATS
  - Decreased absorption when given with sucralfate, calcium-and iron-containing products, antacids
  - Enamel discolorization
  - IV doxycycline-NO HORSE

Nitroimidazoles

- Bactericidal/protozoacidal
  - Obligate anaerobes
  - Protozoa
- Most common
  - Metronidazole
  - Ronidazole
- Caution
  - Neurotoxicity (dose related)
  - ILLEGAL in food producing animals

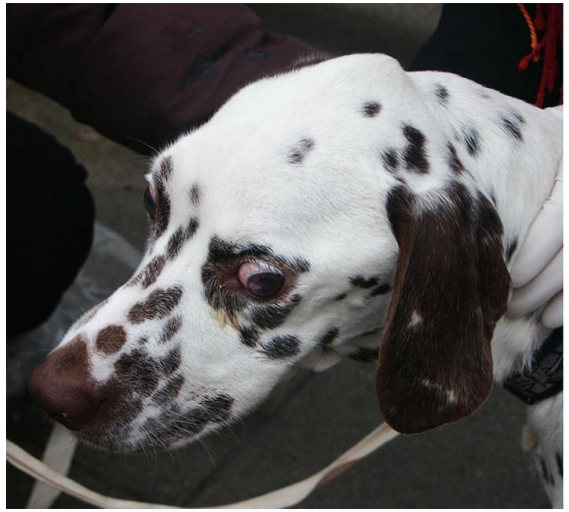
Antifungal Drugs

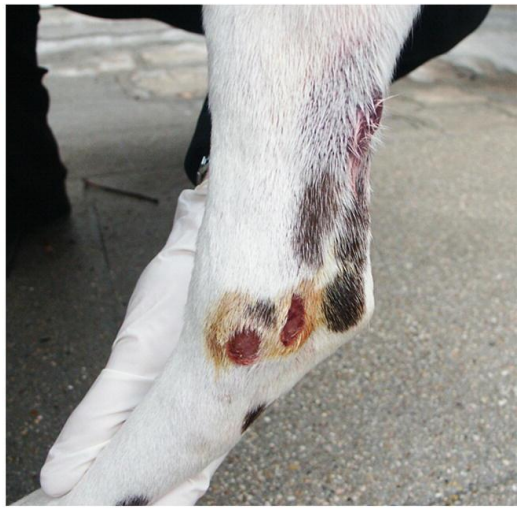
- Fungal infection can arise from a variety of organisms
  - *Blastomyces*
  - *Histoplasma*
  - *Cryptococcus*
  - *Aspergillus*
- Yeast
  - *Candida*
  - *Malassezia*
- Dermatophytes
  - *Micosporum*
  - *Trichophyton*

- Skin and ear infections
  - TX with topical antifungals
    - Clotrimazole
    - Nystatin
- Disseminated infections
  - Systemic antifungals
    - Amphotericin B
    - Ketoconazole
    - Fluconazole
    - Itraconazole

Antifungal Mechanism of Action

- Selectively bind to OR inhibit synthesis of ergosterol in the cell membrane
  - Cell death
- Systemic fungal infection takes weeks to months of antifungal treatment
- CAUTION
  - Decreased appetite
  - Anorexia
  - Vomiting
  - Liver and renal chemistries should be monitored with systemic antifungal use
    - Organ toxicities





Antiparasitic Drugs

Benzimidazoles

- Fenbendazole
- Albendazole
- Netobimin
- Febantel
- MOA
  - Binds parasitic beta-tubulin
- Activity
  - Nematodes
  - Lungworms
  - Cestodes
  - Giardia
- Target Species
  - Cattle
  - Goats
  - Sheep
  - Horses
  - Poultry
  - Pigs
  - Dogs/Cats
- CAUTION
  - Wide margin of safety
  - Teratogenic (some)

Tetrahydropyrimidines

- Pyrantel
- Morantel
- MOA
  - Agonist at parasitic nicotinic acetylcholine receptors
- Activity
  - Nematodes
- Target Species
  - Sheep
  - Cattle
  - Pigs
  - Horses
  - Dogs/Cats
- CAUTION
  - Not intended for horses intended for food consumption

Tetrahydropyrimidines

- Praziquantel
- MOA
  - Alter parasite intracellular calcium concentration
    - Causes detachment and digestion of host
- Activity
  - Cestodes
  - Trematodes
- Target Species
  - Dogs/Cats
  - Cattle
  - Sheep
  - Goats
  - Pigs
  - Horses
- CAUTION
  - Vomiting at high doses (dogs)

Tetrahydropyrimidines

- Epsiprantel
- MOA
  - Alter parasite intracellular calcium concentration
    - Causes detachment and digestion of host
- Activity
  - Cestodes
- Target Species
  - Dogs/Cats
- CAUTION
  - Wide margin of safety

Avermectins

- Ivermectin
- Doramectin
- Selamectin
- Milbemycin
  - Moxidectin
  - Milbemycin oxime
- MOA
  - Agonist at invertebrate glutamate-gated chloride channels
    - Causing flaccid paralysis
- Activity
  - Nematodes
  - Arthropods
- Target Species
  - Cattle
  - Sheep
  - Horses
  - Pigs
  - Dogs/Cats
- CAUTION
  - Genetic predisposition for CNS toxicity in Collies and related breeds
  - Restricted use in lactating dairy cows (except some topical formulations)

Sulfadimethoxine

- Albon
- MOA
  - Prevent parasite production of folic acid
    - Preventing replication
- Activity
  - Coccidia
  - Toxoplasma
- Target Species
  - Dogs
- CAUTION
  - Crystalluria
  - Hypersensitivity reactions
  - KCS
  - Bone marrow suppression
  - Polyarthritis

Melarsomine

- Diroban
- Immiticide
- MOA
  - Arsenic compound
  - Exact MOA unknown
- Activity
  - Adult heartworms
- Target Species
  - Dogs
- CAUTION
  - Toxic to cats
  - Deep IM injection ONLY

Contact Insecticides

Contact Insecticide

- Organophosphates
- Pyrethrins
- MOA
  - Organophosphates-inhibition of acetylcholinesterase
  - Pyrethrins-target voltage-gated Na channels of the axonal cell membrane
- Activity
  - Organophosphates-Fleas, ticks, mites, flies, lice, and grubs
  - Pyrethrins-Mosquitos, ticks, fleas, mites
- Target Species
  - Organophosphates-Cattle, dogs, and cats
  - Pyrethrins-Cattle, pig, dog
- CAUTION
  - Organophosphates-Salivation, urination, defecation, depression, twitching, tremors
  - Pyrethrins- Hyperexcitability, tremors, salivation, weakness
    - NOT SAFE IN CATS

Agents That Target Parasite's Nervous System

Avermectins

- MOA
  - Target invertebrate glutamate-gated Cl channels
  - Cross-reactivity with mammal GABA and glycine-gated Cl channels
- Activity
  - Lice, mites, flies, grubs, and ticks
- Target Species
  - Cattle, pig, dogs, and cats
- CAUTION
  - CNS depression, ataxia, Collies have a sensitivity

Amitraz

- MOA
  - Monoamine oxidase inhibitor
- Activity
  - Ticks, lice, mites
- Target Species
  - Dogs, cattle, pig
- CAUTION
  - CNS depression

Fipronil

- MOA
  - Noncompetitive blockade of Cl ions through GABA and invertebrate glutamate-gated Cl channels
- Activity
  - Fleas and ticks
- Target Species
  - Dogs and cats
- CAUTION
  - Hyperactivity and convulsions

Imidacloprid

- MOA
  - Competitive inhibition of invertebrate nicotinic acetylcholine receptors
- Activity
  - Fleas
    - Larvae
    - Adults
- Target Species
  - Dogs and cats
- CAUTION
  - Tremors

Nitenpyram

- MOA
  - Competitive inhibition of invertebrate nicotinic acetylcholine receptors
- Activity
  - Fleas

- Target Species
  - Dogs and cats
- CAUTION

  Well tolerated

Afoxolaner

- MOA
  - Noncompetitive blockade of Cl ions through invertebrate GABA-gated Cl channels
- Activity
  - Fleas and ticks
- Target Species
  - Dogs
- CAUTION
  - Well tolerated

Spinosad

- MOA
  - Activation of invertebrate acetylcholine receptors
- Activity
  - Fleas
- Target Species
  - Dogs and cats
- CAUTION
  - Vomiting, diarrhea, and anorexia

Insect Growth Regulators

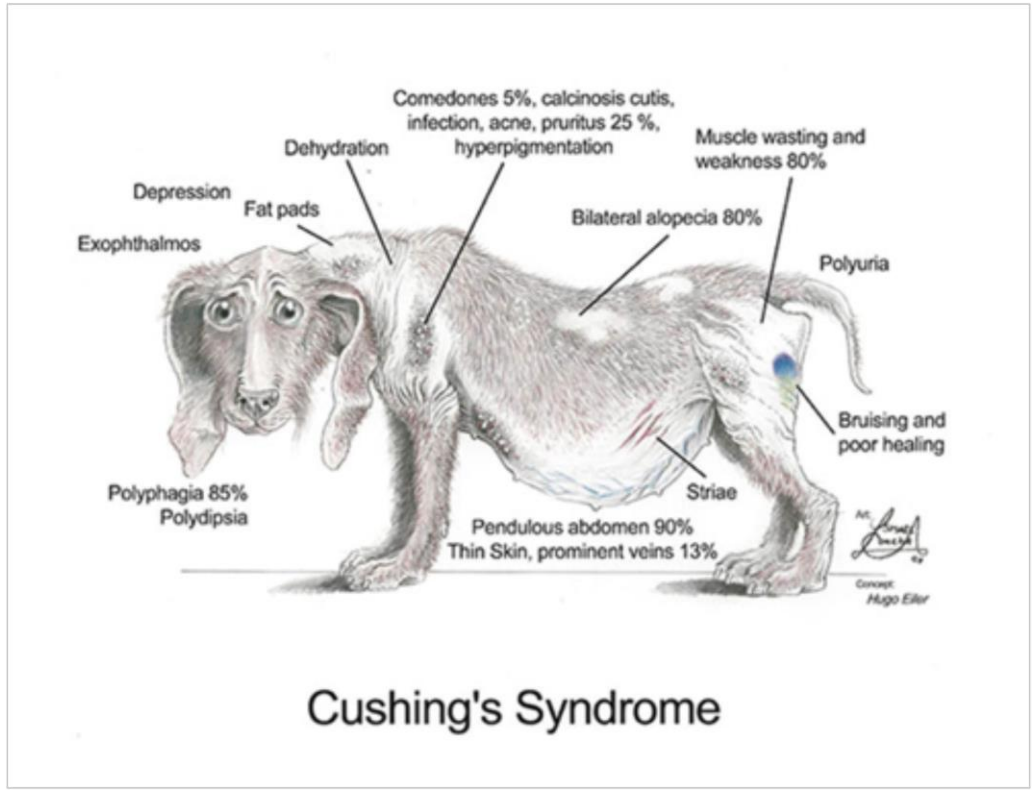
Pyriproxifen/Methoprene

- MOA
  - Juvenile hormone analogues
    - Maintain insect development in immature egg or larval stages
- Activity
  - Fleas, flies, mosquitos
- Target Species
  - Dogs, cats, and cattle
- CAUTION
  - Well tolerated

Lufenuron/Diflubenzuron

- MOA
  - Insect development inhibitor
    - Inhibits chitin synthesis and deposition, interfering with development of insect's exoskeleton
- Activity
  - Fleas and flies

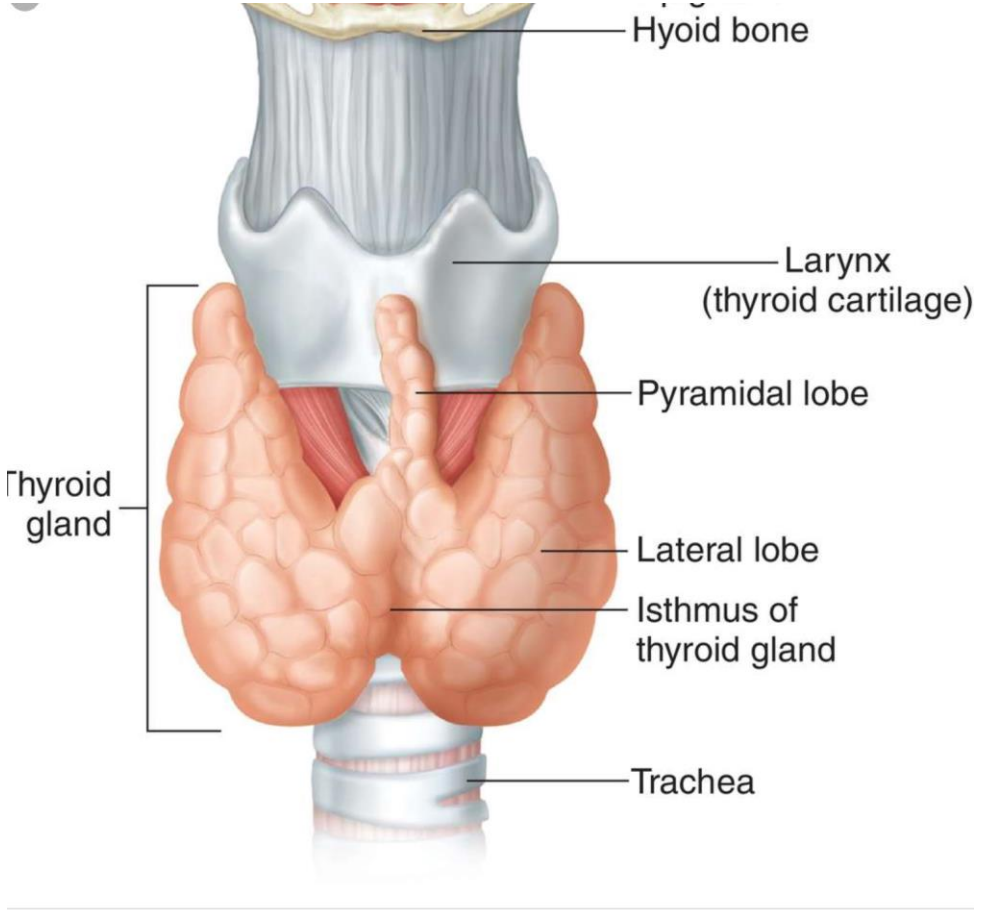
- Target Species
  - Dogs, cats, and horses
- CAUTION
  - Tissue reaction to injectable



Endocrine Drugs

Thyroid Disease

- Hypothyroidism
  - Levothyroxine
- Hyperthyroidism
  - Increase in thyroid hormone production
- Most common in cats and is associated with a hormone-secreting thyroid tumor
- Hyperthyroidism is treated by surgical removal of the thyroid gland, drugs that destroy thyroid tissue, or radiation (I-131)
  - Methimazole



Hyperadrenocorticism (CUSHINGS)

- Mitotane
  - Lysodren®, Lisodren®
  - Anticancer medication that is toxic to the adrenal gland cells and is used to treat hyperadrenocorticism or adrenal gland carcinoma
- Trilostane
  - Vetoryl®, Desopan®, Modrastane®, or Modrenal®
  - FDA approved for the medical management of dogs with pituitary-dependent hyperadrenocorticism (PDH) as well as adrenal-dependent hyperadrenocorticism (ADH)

- Caution
  - Generally well-tolerated; however, side effects can include lethargy, vomiting, diarrhea, and lack of appetite during the first few days of therapy
  - Addisonian Crisis
  - Side effects when used with
    - ACE inhibitors
    - Aminoglutethimide
    - Ketoconazole
    - Mitotane
    - Potassium-sparing diuretics (spironolactone)
    - Potassium supplements

Hyporadrenocorticism (ADDISONS)

- Fludrocortisone
  - Florinef®, Astonin®, Astonin H®, Florinefe®, Lonikan®
  - Mineralocorticoid that is used to treat hypoadrenocorticism
- Caution
  - Side effects are uncommon but may include vomiting
  - Serious side effects associated with chronically high doses include increased thirst and urination, body swelling, weight gain, pot belly appearance
  - Serious side effects associated with a dose that is too low includes weakness, tiredness, shaking collapse, lack of appetite, vomiting, diarrhea, weight loss, and a low heart rate

Hyporadrenocorticism (ADDISONS)

- Desoxycorticosterone
  - Zycortal, Percorten V, Percorten M
  - Corticosteroid and mineralocorticoid that is used to treat hypoadrenocorticism
- Caution
  - Side effects reported were polyuria, polydipsia, depression/lethargy, pain on injection, weight gain, inappropriate urination, alopecia, decreased appetite/anorexia, panting, vomiting, diarrhea, shaking/trembling, polyphagia, urinary tract infection, urinary tract incontinence, anaphylaxis, anemia, restlessness and collapse
  - Caution in dogs with congestive heart disease, edema, severe renal disease or primary hepatic failure

Insulin

Insulin is responsible for the movement of glucose from the blood into tissue cells

Lack of insulin=DM

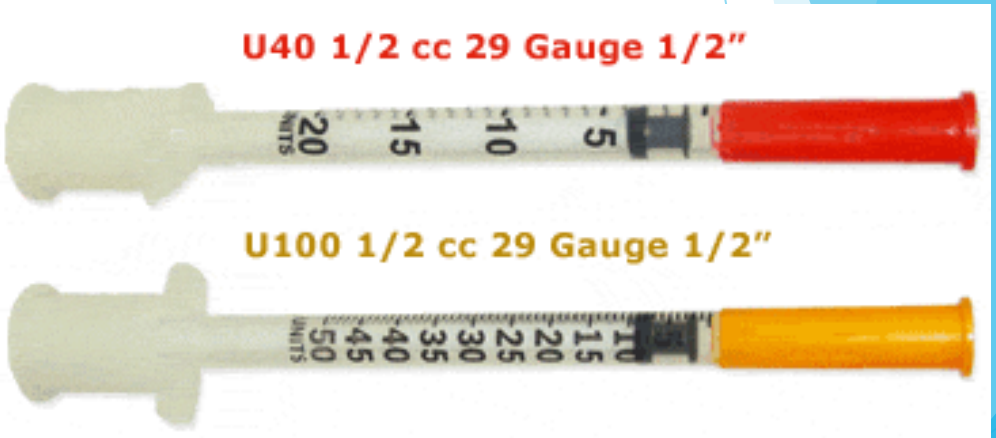
Insulin

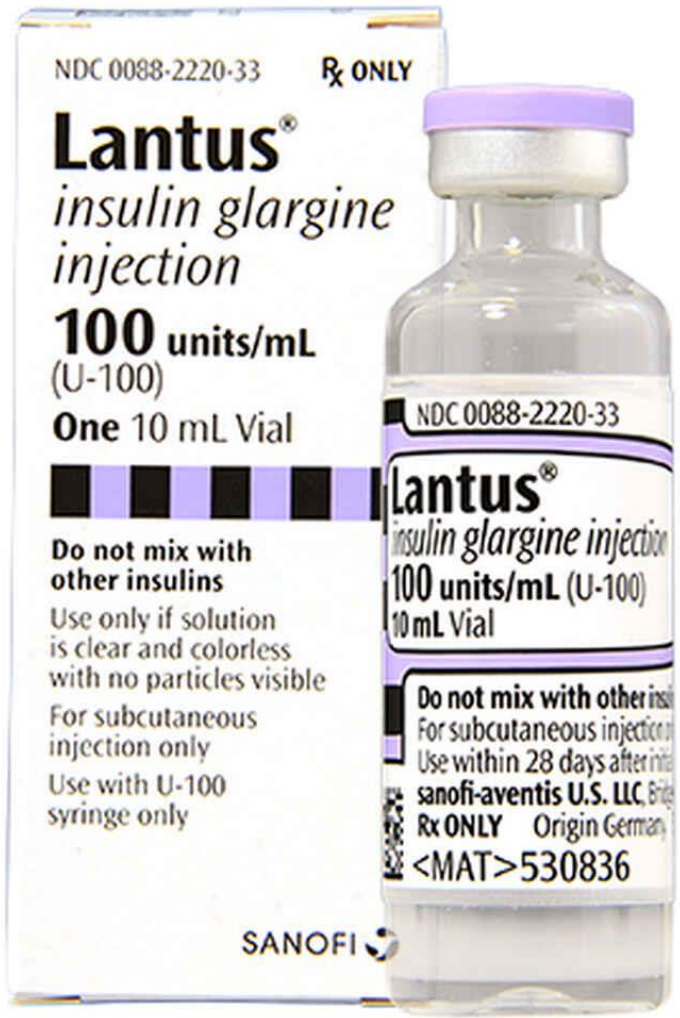
Administered SQ sid to bid

Regular insulin is utilized in an ER crisis only

Insulin syringe

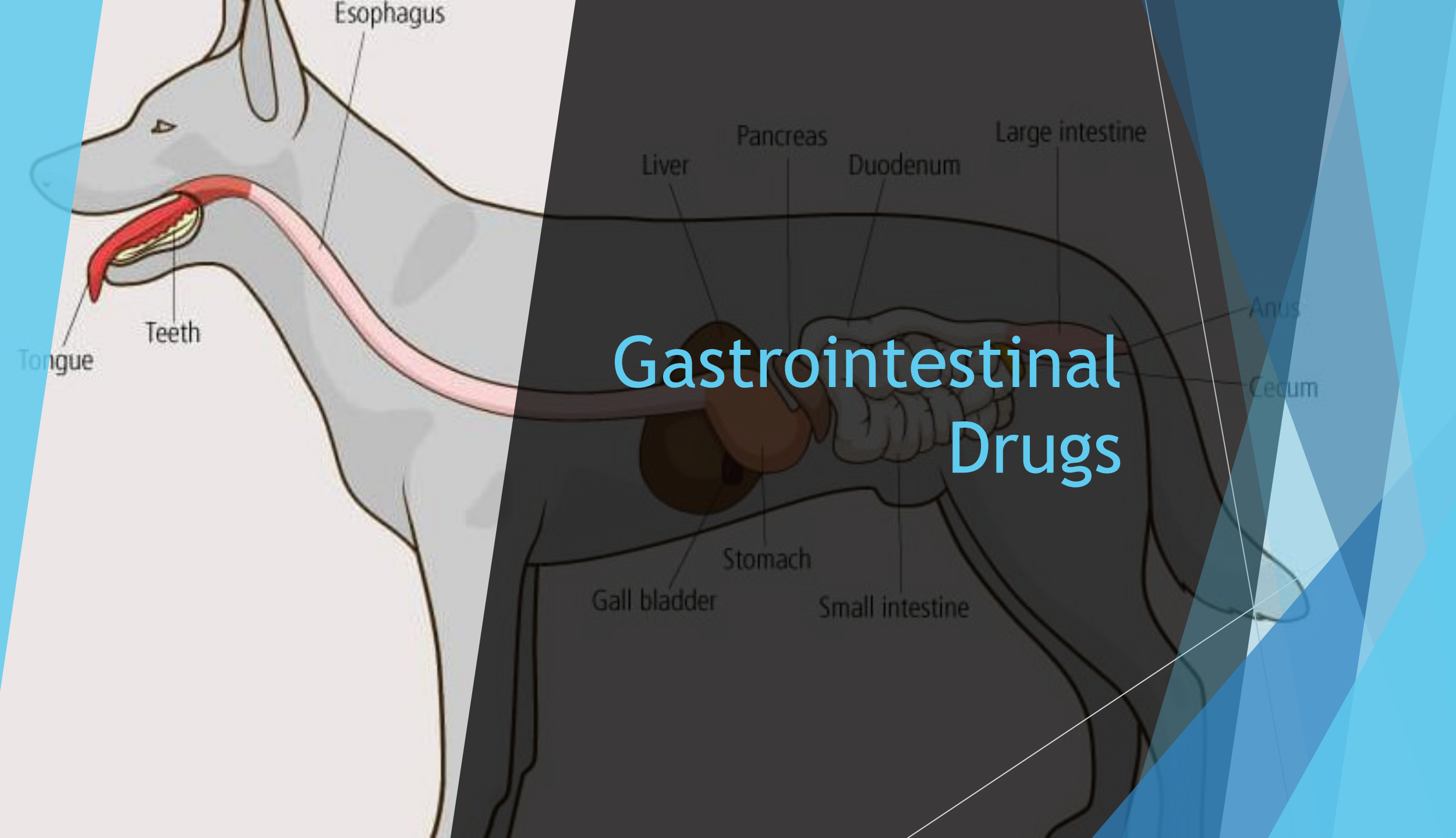
- Supplied with a 25G (gauge) needle
- No dead space
- Precise dosing
- Syringe is divided into units NOT cc
  - 1U = 0.01 mL
- 100u (unit) and 40u insulin syringes
- **DIFFERENT SIZES!!!**
- **Not all insulin utilizes the same insulin syringe!!**





Insulin

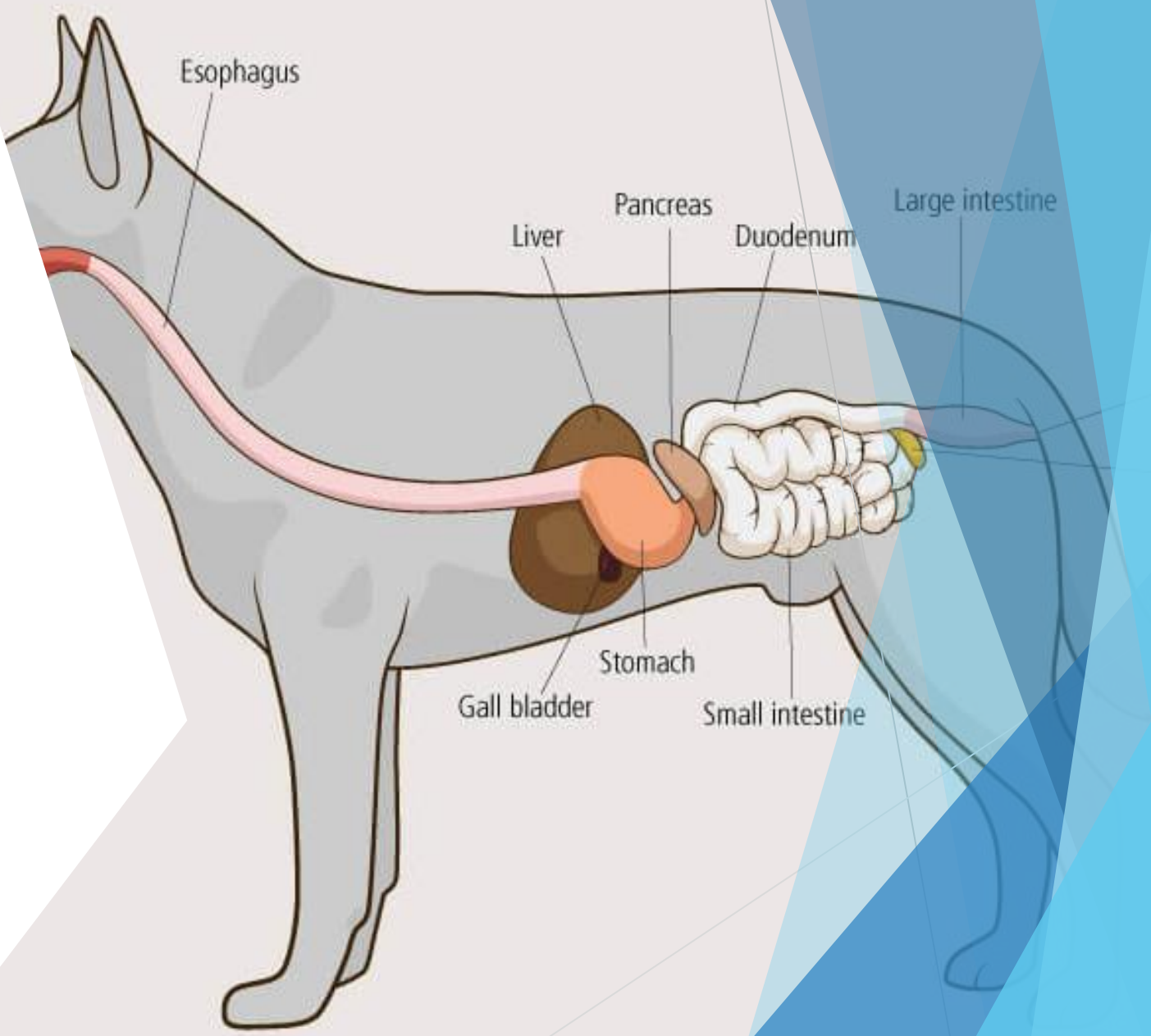
- Porcine or Bovine
  - Vetsulin (porcine)
  - PZI (bovine)
- Human derived
  - Humulin
  - Novolin
- Genetically engineered
  - Human Recombinant
    - ProZINC
- Synthetic
  - Glargine
  - Levemir



Gastrointestinal Drugs

Drugs affecting the GI tract

- Drugs related to the stomach are called gastric
  - Gastric ulcers
  - Gastric blood flow
  - Gastric emptying
- Drugs related to the duodenum, jejunum, or ileum are referred to as enteric
- Drugs and functions related to the colon are referred to as colonic



Emetics

- Drugs that induce vomiting
- Emetics are most often used to induce vomiting in animals that have ingested toxic substances
- Emetics should not be utilized in every case of poisoning
    - Caustic substances
    - Sharp objects
    - Brachycephalic dogs
- Under direct supervision ONLY due to the risk of aspiration

Emetics

Apomorphine

- Administered IV or IM
- Not effective in cats
  - Xylazine or dexmedetomidine
- Both produce emesis within minutes!
- Animals will vomit entire stomach contents (up to 85%)
- Vomiting will cease on own once stomach is evacuated

Antiemetics

- Drugs that prevent or decrease vomiting/nausea
- Antiemetics should only be used when the vomiting reflex is no longer of benefit to the animal
  - Phenothiazines
  - Dramamine
  - Benadryl
  - Cerenia
  - Reglan
  - Ondansetron

Antidiarrheals

- Drugs used to combat various types of diarrhea
- Narcotics slow gastrointestinal motility
  - Lomotil
  - Loperamide
    - Imodium
  - Pepto-Bismol
  - Use cautiously contains salicylate
  - Aspirin-like compound
  - Not safe in cats!
- Use cautiously in cats
- Can induce dysphoria

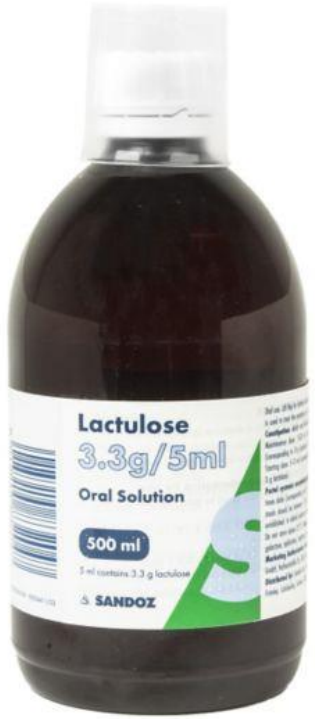
Probiotics

- Probiotics boost the healthy gut bacteria, or microbiomes, that digest food
  - FortiFlora
  - Proviable
- Probiotics are measured in Colony Forming Units, or CFUs
  - The current recommendation for dogs is 1 to 10 billion CFUs a day

- Conditions that may benefit
  - Allergies
  - Anxiety
  - Bad breath
  - Coat quality
  - Diarrhea
  - Immune disorders
  - Intestinal inflammation
  - Irritable bowel syndrome
  - Liver disease
  - Obesity
  - Skin disorders
  - Urinary tract infections

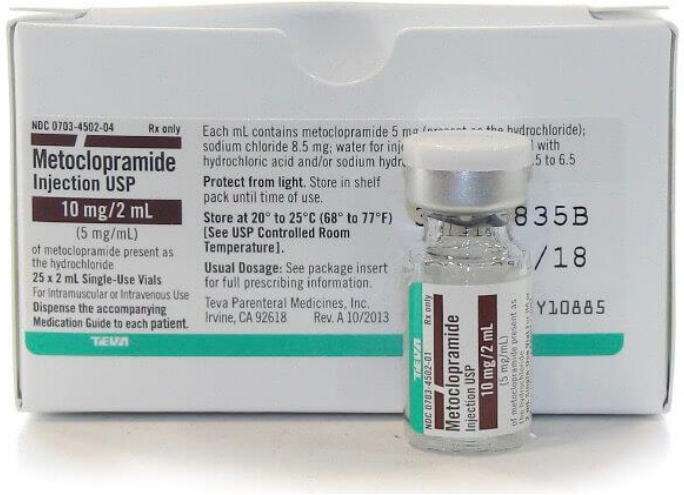
Laxatives, Lubricants, and Stool Softeners

- Laxatives, cathartics, and purgatives facilitate evacuation of the bowels
- Lactulose
  - Laxative that increases osmotic pressure by drawing water into the colon, which results in fecal material containing more liquid
  - It can also have an acidifying action that is used in the treatment of hepatic encephalopathy because it traps ammonia in the form of ammonium
- Utilized in animals with chronic constipation problems



Prokinetics

- Increase the movement of ingested material through the GI tract
- Useful in the TX of motility disorders
  - Induce coordinated motility pattern



Metoclopramide

- Stimulates and coordinates esophageal, gastric, pyloric, and duodenal motor activity
- It increases lower esophageal sphincter tone and stimulates gastric contractions, while relaxing the pylorus and duodenum

Cisapride

- More potent and has broader prokinetic activity than metoclopramide, increasing the motility of the colon, as well as that of the esophagus, stomach, and small intestine

Antacids

- Reduce acidity of the stomach
  - TUMS
  - Rolaids
- Non-systemic
  - Primarily made of calcium
  - Maalox
  - Magnesium and aluminum product
    - Utilized as a phosphate binder in CRF
- Systemic antacids
  - Decrease acid production in the stomach
    - Famtotidine
    - Rantitidine
    - Cimetidine

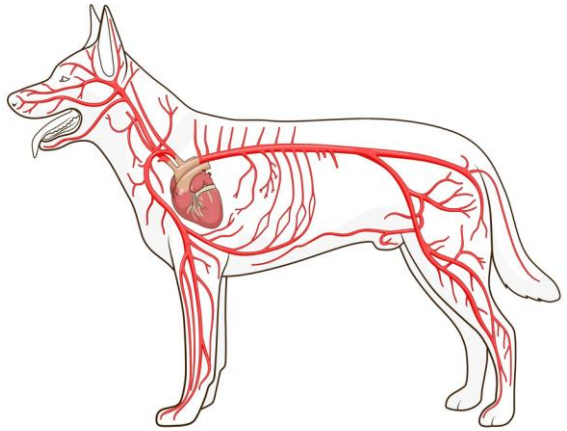
Antiulcer

- Gastric “band-aid”
- Sucralfate
  - Forms a sticky paste and adheres to ulcers; protecting them from the acidic environment of the stomach
- Omeprazole (Prilosec)
  - Antacid and antiulcer properties
- Misoprostol
  - Synthetic prostaglandin that helps decrease acid secretion in the stomach and increases production of the stomach lining
- Treatment for NSAID complications

Appetite Stimulants

- Cyproheptadine
- Diazepam
  - Valium
- Mirtrazipine
- All typically utilized in cats
- Entyce

Drugs affecting the cardiovascular system



- Antiarrhythmic drugs
- An arrhythmia is any abnormal pattern of electrical activity in the heart
- Arrhythmias are divided into two general groups
  - Arrhythmias that result in tachycardia
  - Arrhythmias that result in bradycardia
- Type must be distinguished before treatment can be ordered
- Antiarrhythmic drugs are used to re-establish a normal conduction sequence (sinus rhythm)
- Lidocaine, mexiletine, quinidine, and procainamide reverse arrhythmias primarily by decreasing the rate of movement of sodium into heart cells

Antiarrhythmic drugs

- When stimulated by the sympathetic nervous system, beta-1 receptors in the heart cause the heart to beat more rapidly and with greater strength
- This can induce severe tachycardia resulting in fatal arrhythmias
- Drugs that block this activity are known as beta blockers
  - Propranolol
- Decreases heart rate and prevents tachycardia in response to stress, fear, or excitement

Antiarrhythmic Drugs

- Calcium channel blockers
  - Diltiazem
- Treatment of supraventricular tachycardia
- Atrial fibrillation
- Atrial flutter
- HCM in cats
- Amlodipine (hypertension)
- This drugs combat arrhythmias by blocking calcium channels of cardiac muscle cells, resulting in decreased conduction of depolarization waves and decreased automaticity of parts of the conduction system

Positive inotropic drugs

- Pimobendan
  - Vetmedin
- Inodilator
- Inotropic and vasodilator effects
- Utilized with other cardiac medications to control CHF secondary to DCM or MV disease

Vasodilators/Antihypertensive

- Enalapril, captopril, and benazepril
  - Ace inhibitors
  - Interaction with NSAIDS!!
  - Competes for same receptor site- resulting in ↓ of BP effects
  - ↑ AKI
- Block angiotensin-converting enzyme and prevent the formation of angiotensin II (potent vasoconstrictor)
- Relax smooth muscles of arterioles and veins
- Useful for treating animals with cardiac disease that involves the right and left ventricles

Antihypertensive

- Calcium Channel Blocker (CCB)
  - Amlodipine
  - Hydralazine
- CCB slow the rate at which calcium moves into the heart and blood-vessel walls
- This enables the blood vessels to relax, which ultimately results in better blood-flow
- The effects of CCB also make it much easier for the heart to pump blood throughout the body, which lowers the pet's blood pressure

Phosphodiesterase Inhibitor

- Medications that promote blood vessel dilation (vasodilation) and smooth muscle relaxation in certain parts of the body, such as the heart, lungs, and genitals
  - Sildenafil/Viagra
- Sildenafil is a drug that is used in dogs and cats with heart and/or lung problems that cause increased blood pressure in the arteries of the lungs

Diuretics

- Drugs that increase urine formation and promote water loss
- In animals with CHF, sodium retention from aldosterone secretion in conjunction to retention of water in the blood and body tissues lead to pulmonary edema, ascites, and increased cardiac workload
- Removing water from the body with diuretics reduces these harmful conditions
- Use cautiously in animals with hypovolemia or hypotension because they further decrease the fluid component of blood and reduce blood pressure

Diuretics

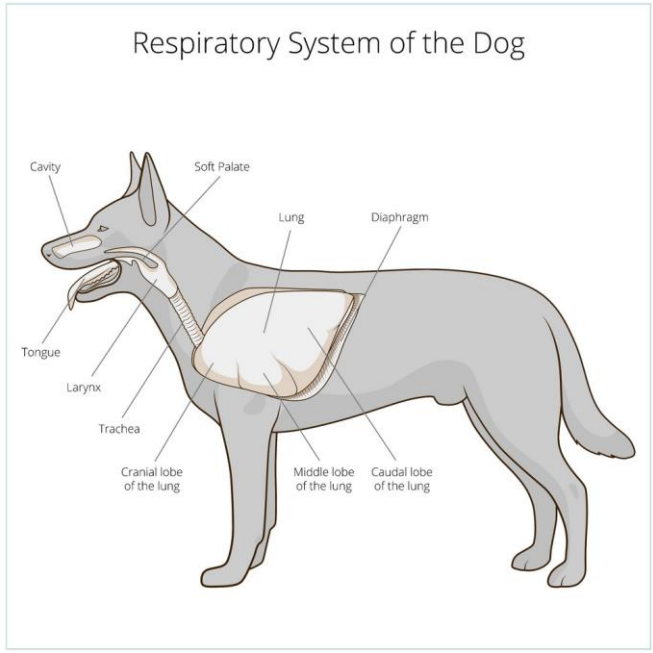
- Lasix
  - Loop diuretic
- Prolonged use may lead to hypokalemia
- Blood potassium levels must be monitored with long term use
- Spironolactone
  - Potassium sparing diuretic
- Mannitol
  - Osmotic diuretic
- Used for cerebral edema associated with head trauma

Anticoagulants

- Blood thinners
  - Chemical substances that prevent or reduce coagulation of blood, prolonging the clotting time
    - Heparin (extra label use)
    - Aspirin
- Hypercoagulable states
  - DIC

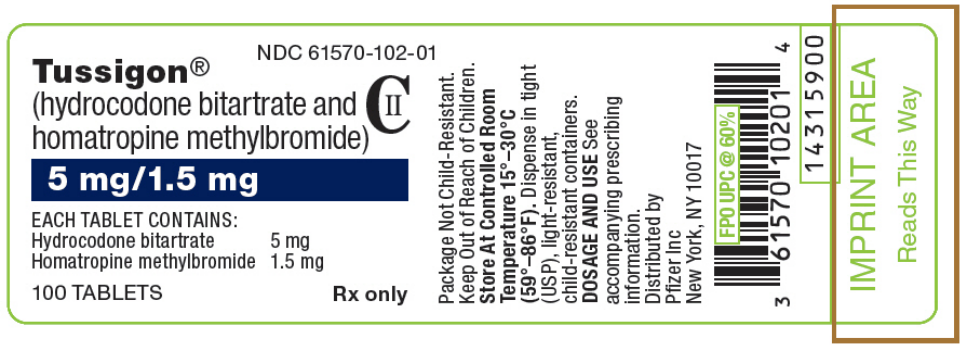
Drugs affecting the respiratory system

- Antitussives
  - Drugs that block the cough reflex, which is coordinated by the cough center in the brainstem
- Productive cough
  - Refers to a cough that produces mucus and other inflammatory products that are coughed up into the oral cavity
- Nonproductive cough
  - Dry and hacking, and no mucus is expelled
- Antitussives suppress the coughing that normally removes mucus, cellular debris, exudates, and other products that accumulate in the bronchi as a result of infection or inflammation



Antitussives

- Use of antitussives in animals with a productive cough may result in pneumonia—use cautiously!
- Antitussives are used in the treatment of tracheobronchitis
  - Torbutrol
  - Hydrocodone
  - Codeine
  - Dextromethorphan

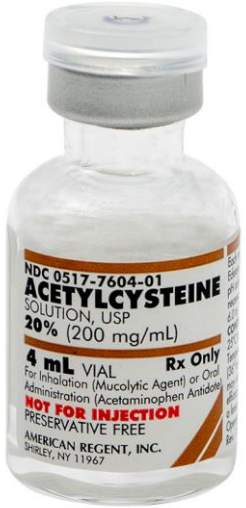


Bronchodilators

- Bronchoconstriction is caused by the contraction of smooth muscles surrounding the small terminal bronchioles deep within the respiratory tree
- Drugs that inhibit bronchoconstriction are called bronchodilators
  - Terbutaline, albuterol, clenbuterol
    - PO
  - Theophylline and aminophylline
    - IV
- Uses:
  - Smoke inhalation
  - Asthma

Expectorants/Mucolytics

- Expectorants and mucolytic drugs are used to increase the output of bronchial secretions, enhance the clearance of bronchial exudate, and promote a productive cough
- N-acetylcysteine
  - Its mucolytic effect is the result of the exposed sulfhydryl groups on the compound, which interact with disulfide bonds on mucoprotein
  - Acetylcysteine helps to break down respiratory mucus and enhance clearance
  - It may also increase the levels of glutathione, which is a scavenger of oxygen-free radicals



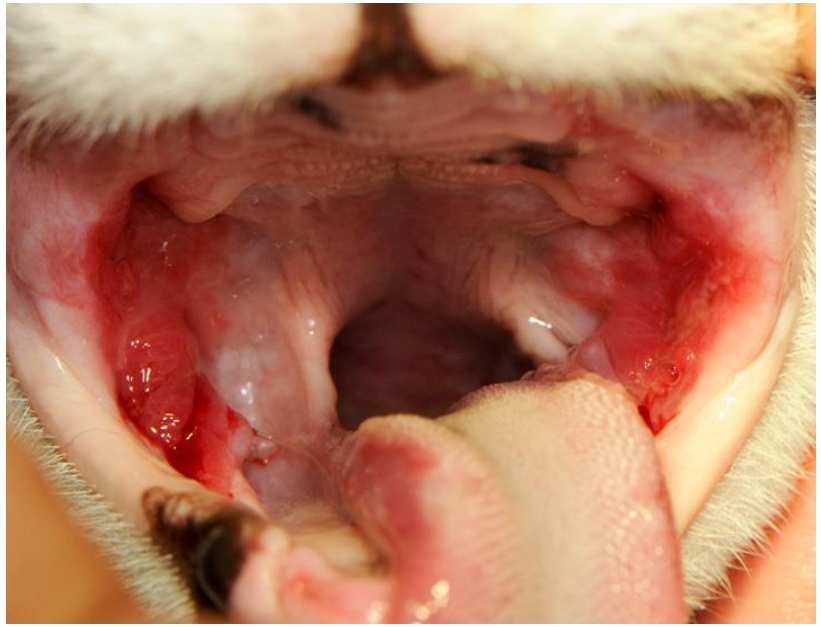
- Guaifenesin
  - Centrally acting muscle relaxant that may also have an expectorant effect
  - It may stimulate bronchial secretions via vagal pathways
  - The volume and viscosity of bronchial secretions does not change, but particle clearance from the airways may accelerate

Respiratory Stimulant

- Doxapram
  - Stimulates the medullary respiratory center and the chemoreceptors of the carotid artery and aorta to increase tidal volume
  - Other areas of the CNS are stimulated only when high doses are administered
  - Doxapram is used primarily in emergency situations during anesthesia or to decrease the respiratory depressant effects of opiates and barbiturates

Anticonvulsants

- Seizures are periods of altered brain function characterized by loss of consciousness, altered muscle tone or movement, altered sensations, or other neurologic changes
- Drugs used to control seizure activity are called anticonvulsants
  - Phenobarbital
  - Potassium bromide (KBr)
  - Dilantin
  - Keppra
  - Zonisamide
  - Valium
- Active seizure activity
  - Propofol prn to control unresponsive seizures



Anti-inflammatory

Drugs that relieve pain or discomfort by blocking or reducing the inflammatory process

Two classes

- NSAIDS (non-steroidal anti-inflammatory drugs
- Steroids

Steroids

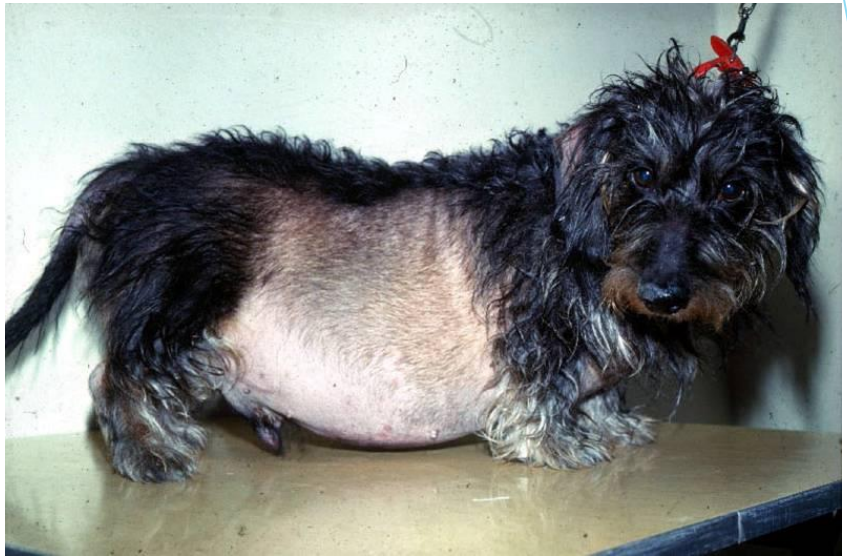
- Cortisone or corticosteroid = glucocorticoids
  - Hydrocortisone
  - Exerts an anti-inflammatory effect for less than 12 hours
- Prednisone, prednisolone, Vetalog
  - Intermediate- acting
  - 12-36 hours
- Dexamethasone
  - Long acting
  - >48 hours

Steroids

Common side effects

- PU/PD
- Increase in appetite
- Larger doses can induce coughing and behavioral changes (agitation)

- Side effects will decrease as the animal's dose is titrated down
- Long-term effects
  - Cushing's disease
  - Alopecia
  - Muscle wasting
  - Pot-bellied appearance
  - Slow healing wounds
  - PU/PD
  - Increased appetite



NSAIDS

- Less side effects when compared to steroid use
- NSAIDS can produce gastric ulcerations or decreased blood flow to the kidneys
  - COX inhibition
- Aspirin is fairly safe in dogs
  - Metabolized by the liver
  - Not recommended—not as safe as veterinary approved NSAIDS
- Ibuprofen and naproxen
  - OTC human NSAIDS
  - NOT SAFE!!!!

NSAIDS

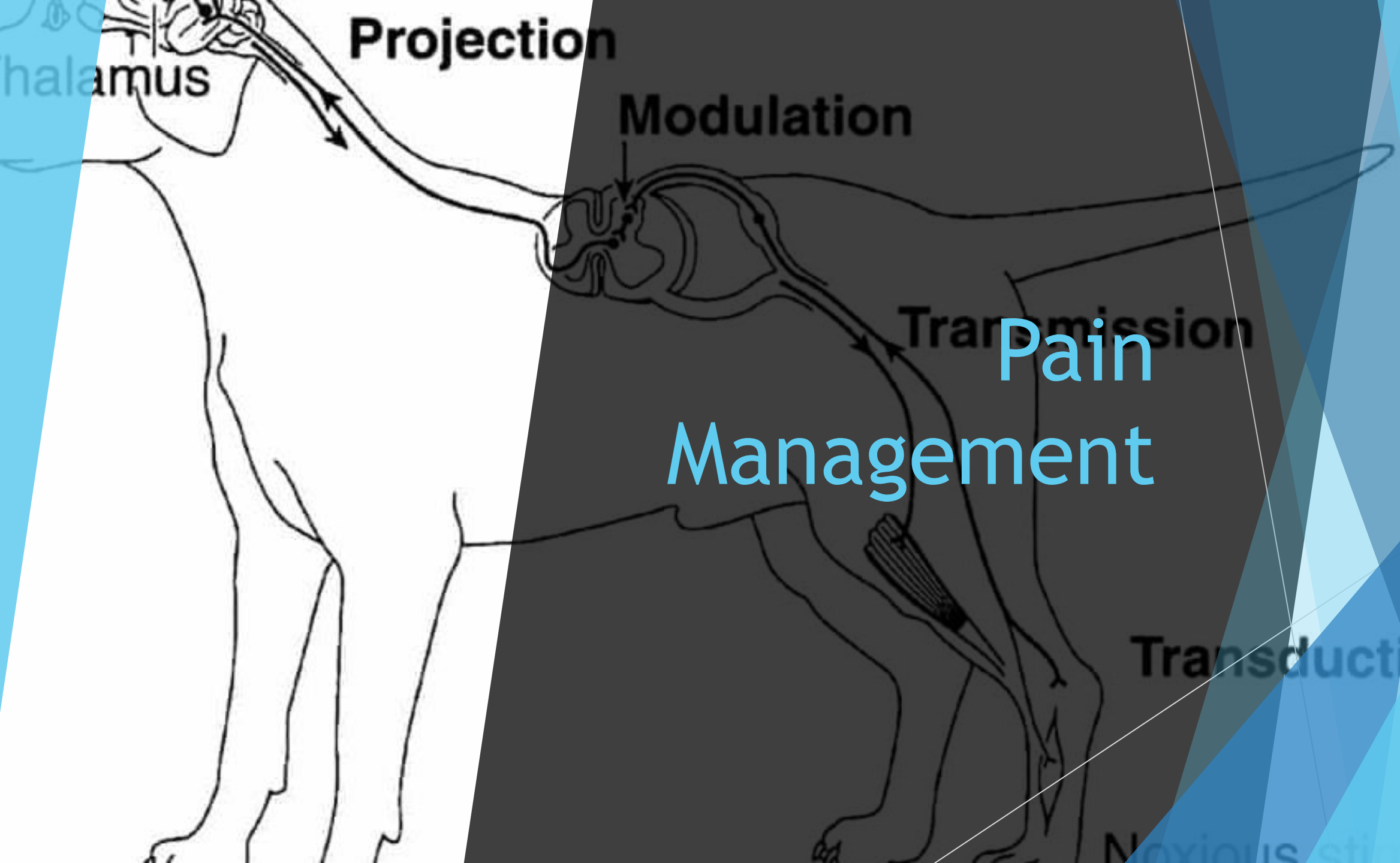
- Carprofen
- COX-1-sparing NSAID, specifically inhibiting COX-2 activity and providing analgesic, antiinflammatory, and antipyretic effects
  - PO sid-bid dosing
  - Most prescribed NSAID
  - For use in dogs ONLY
- Deracoxib (Deramaxx)
- Completely inhibits COX-2 and completely leaves COX-1 alone
  - PO sid dosing
  - Most prescribed
  - For use in dogs ONLY

NSAIDS

- Meloxicam
  - COX-2 inhibitory activity
  - Approved for the use in dogs (po formulations)
  - Injectable approved for use in dogs and cats
  - PO sid dosing
  - Liquid form
- Onsior
  - Selective COX-2 inhibitor in the cat
  - PO sid dosing x 3 days ONLY

NSAIDS

- Firocoxib
  - COX-2 inhibitory activity
- Firocoxib was the first COX-2 inhibitor approved by the U.S. Food and Drug Administration for horses
- Can be used in dogs
- Oral formulation



Pain Management

Physiology of pain

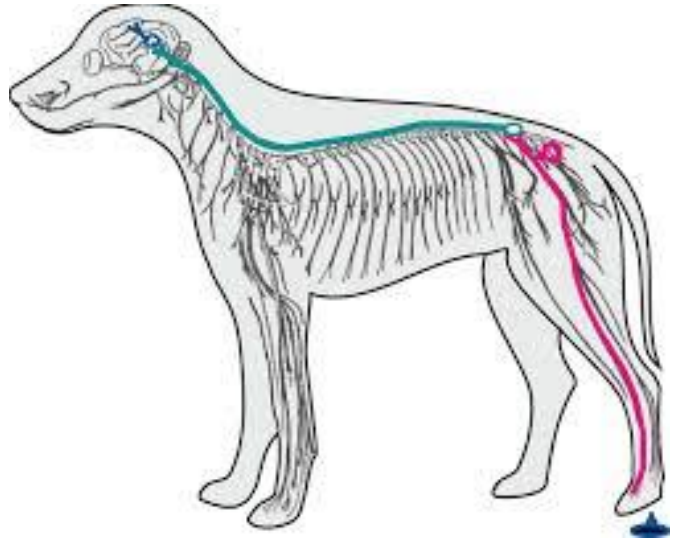
- Nociception: detection by the nervous system for the potential for, or actual tissue injury
- Protects animal from painful or noxious stimuli

Physiologic pain (adaptive)

- Ouch pain
- Little or no tissue injury

Pathologic pain

- Follows tissue injury
- Acute or chronic



Pathologic pain

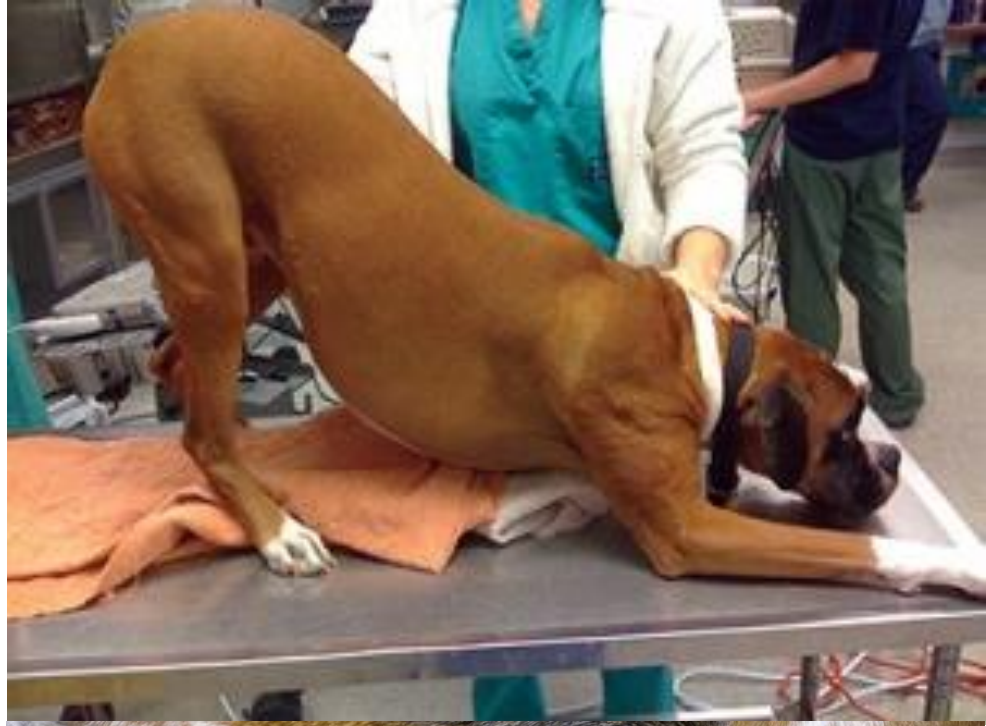
Classification based on mechanism	• Inflammatory, neuropathic, cancer, idiopathic
Classification based on origin	• Visceral or somatic: • Superficial or deep
Classification based on the severity of pain	• None, mild, moderate, severe

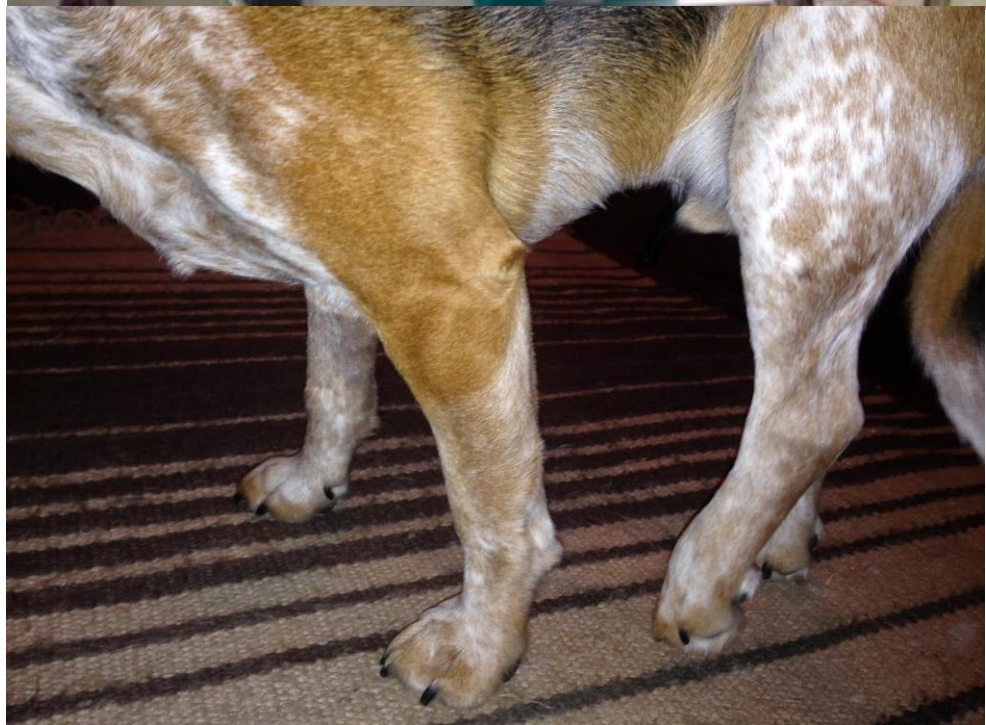
Behavioral responses to pain

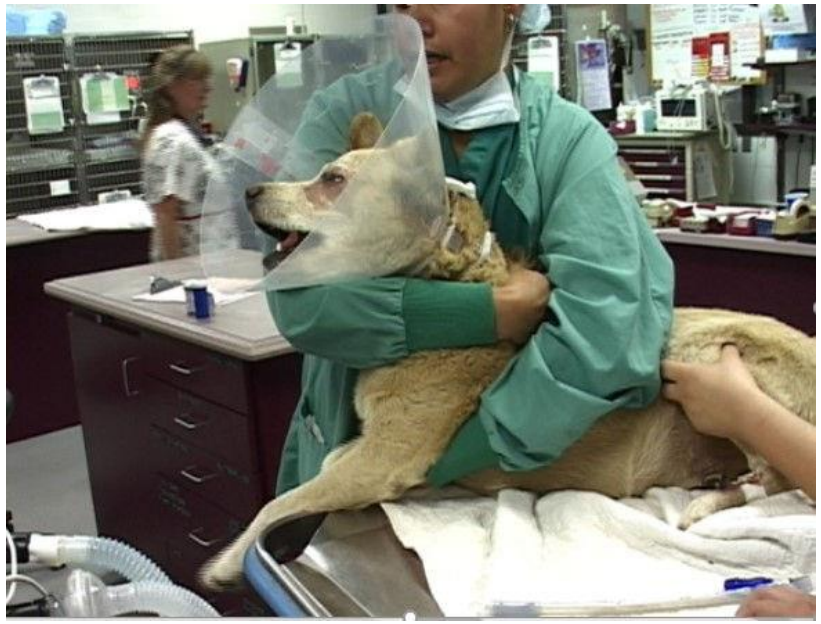
- Vary depending on species, age, breed, and temperament
  - Young patients less tolerant
- Large dog breeds more stoic than small toy breeds
- Cats hide; dogs seek owner comfort
- Vary depending on nature, duration, and severity of pain and presence of humans

Physical evidence of pain

- Changes in gait and level of activity
  - Evidence of arthritic pain
- Reluctance to lie down or constantly shifting position
  - Evidence of thoracic or abdominal pain
- Vocalization
  - Whine, growl, whimper, groan, snarl, bite, hiss, grunt, or purr
- Changes in facial expressions, appearance, and attitude



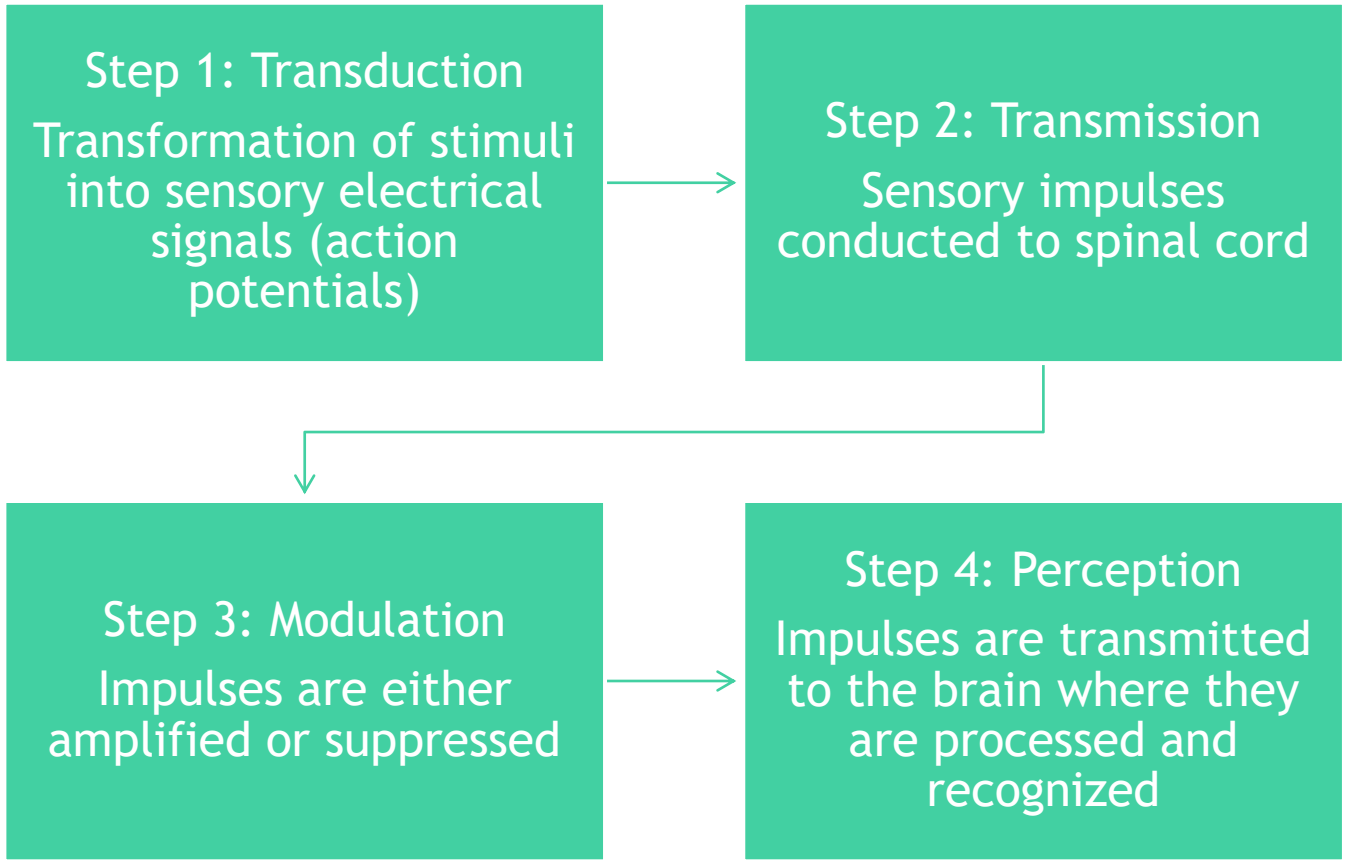


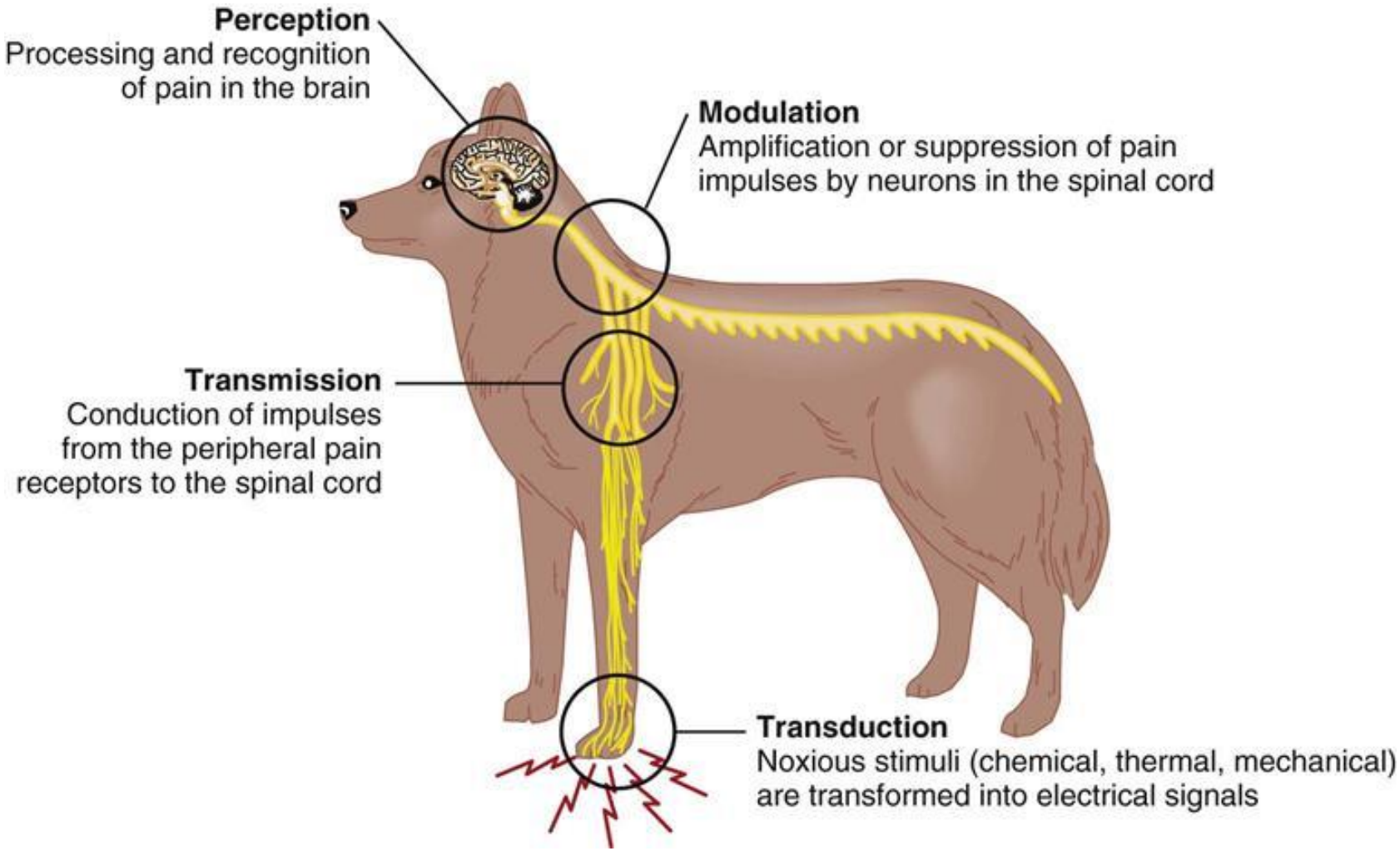


Ruling out dysphoria

- Clinical signs of dysphoria include vocalization, panting, difficulty settling down, and restlessness
- Animals with dysphoria may not be mentally appropriate, they may urinate, defecate or salivate without control
- Efforts to contain or provide comfort to these animals will prove futile

Nociception: The Pain Pathway




Perception
Processing and recognition of pain in the brain
Modulation
Amplification or suppression of pain impulses by neurons in the spinal cord
Transmission
Conduction of impulses from the peripheral pain receptors to the spinal cord
Transduction
Noxious stimuli (chemical, thermal, mechanical) are transformed into electrical signals

Wind-up phenomenon

- The central nervous system adapts adversely to repetitive pain impulses after prolonged stimulation of nociceptors
- This can cause a profound effect to the nervous system's architecture, thereby altering pain processing
- When spinal neurons are subjected to repeat or high-intensity nociceptive impulses, they become progressively and increasingly excitable even after the stimulus is removed
- This condition is known as central sensitization or wind-up phenomenon and leads to nonresponsive or chronic intractable pain

Wind-up is the culmination of two distinct phases of change in the nervous system

- First, pain-transmitting nerve fiber threshold is reset
- This resetting results in hyperalgesia, where less and less stimulation is required to initiate pain
- Second phase, nerve fibers that normally carry non painful information are recruited and become part of the pain-transmission process
- This phase is termed allodynia and results in normally harmless sensations being interpreted as pain
- The presence of hyperalgesia and allodynia collectively is considered wind-up phenomenon
- Dachshund with disk disease that cries out in pain when any part of its body is touched, or the cocker spaniel with a chronic ear infection that can no longer tolerate normal petting.
- This phenomenon highlights the need for preemptive analgesia to treat pain before it begins and at regular intervals postoperatively.

Perioperative pain management

Preemptive Analgesia

- Begins in preoperative period with premedication
- May be administered as part of anesthetic premedication

Multimodal Therapy

- The use of more than one drug to control pain
- Cover multiple receptors and mechanisms of action
- Reduce dose of individual drugs and anesthetic agent

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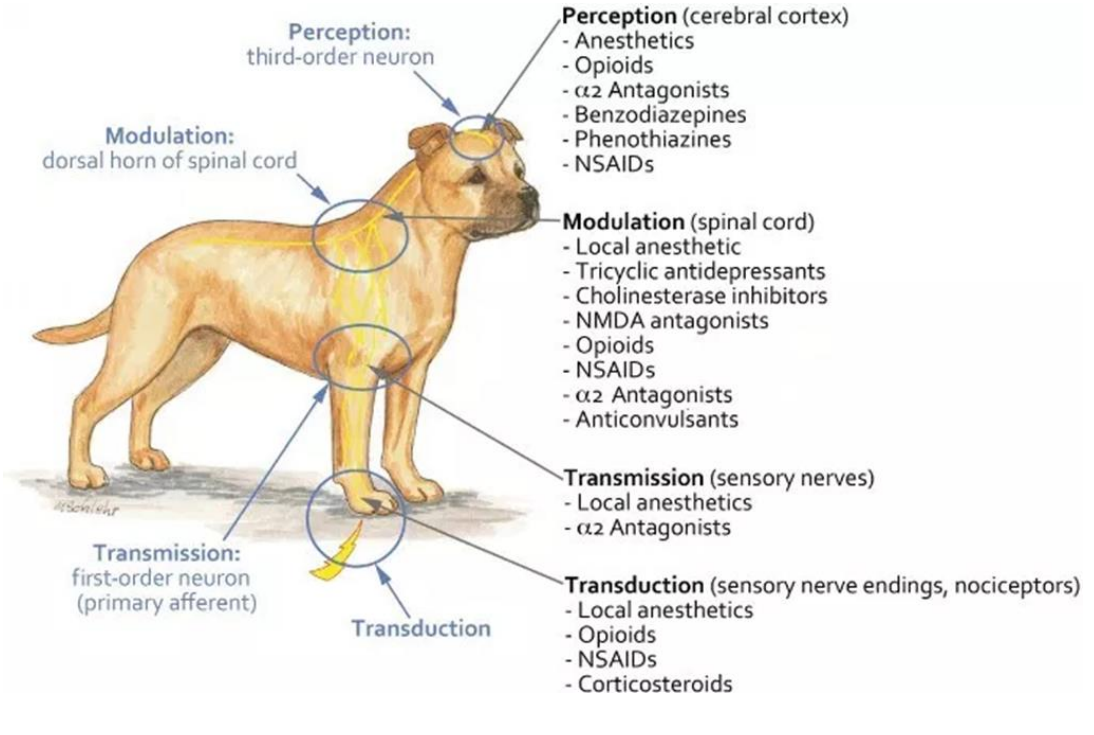
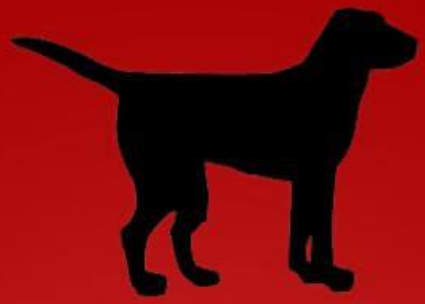


Pharmacologic analgesic therapy

- Choice of drug depends on:
  - Severity and type of pain
  - Patient's general condition
  - Route of delivery



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AND

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