2026 ISVMA VTNE Masterclass: Pharmacology concepts

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Objectives

- Understand effective approaches for studying pharmacology content
- Review basic pharmacologic principles and terminology
- Examine drug classes and effects
  - Look at the "big picture"
- Discuss specific drug characteristics
  - What makes certain drugs stand out in their classes?

In this PowerPoint, drug chemical classes are underlined and drugs are in **boldface**

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General study suggestions

- Know your learning style(s)
- Don't just memorize!
- Understand concepts, effects of different drug classes
- Create outlines/flow charts/mind maps
- Make your own study content
- Explain to others
- Combine content to see applications

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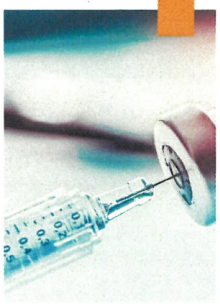
Dosing and administration

Different options for different situations

- Oral
- Injectable/parenteral
- Topical
- Inhaled

- Compounded medications



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Pharmacy management

- The five "rights"
  - Drug, amount, dose, time, patient
- OTC vs. prescription
  - Know which meds require a prescription, and prescription requirements for your state
  - Understand VCPR definition for your state
- Legend/brand-name vs. generic
  - Same bioavailability
- Understand drug labeling
  - Know abbreviations
- Controlled substance handling and laws
  - Federal vs. state
  - Record keeping, handling, storage, disposal

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Pharmacokinetics

- Absorption
  - How drugs enter the bloodstream
  - "First pass effect" with oral meds
- Distribution
  - How medications move from site of absorption to site of action
  - Blood flow, barriers important
- Metabolism
  - How the body utilizes and alters medications
- Excretion
  - How drugs exit the body
  - Withdrawal/withholding times

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Pharmacodynamics

- How drugs produce their effects on the body
  - Affinity, efficacy, potency
  - Agonist, antagonist
- Therapeutic index: "margin of safety"
  - Ratio of LD50:ED50
- Drug interactions
  - Pharmacokinetic, pharmacodynamic, pharmaceutic
  - Adverse/idiosyncratic reactions

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Sample question

- Which step of pharmacokinetics involves biochemical alteration of a drug?
  - A. Absorption
  - B. Distribution
  - C. Metabolism
  - D. Excretion

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Antiparasitics--general

- Helpful to remember classes of parasites
  - Nematodes
  - Trematodes
  - Cestodes
  - Protozoa
    - Limited treatment options available
  - Insects
  - Arachnids
- Helpful to remember parasite life cycles

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Endoparasiticides

- Benzimidazoles
  - Nematodes, some trematodes and cestodes, some protozoa; safe for a wide variety of patients (incl. exotics)
  - **Fenbendazole, thiabendazole, albendazole, oxbendazole**
- Imidazoles
  - Primarily nematodes; good for both large and small animals
  - **Febantel, levamisole**
- Tetrahydropyrimidines
  - Very safe but fewer types of nematodes treated
  - **Pyrantel, Morantel**
- **Piperazine**
  - Safe, and often OTC, but only ascarids
- Isoquinolones
  - Cestodes, some trematodes
  - **Praziquantel, epsiprantel**

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Ectoparasiticides

- **Imidacloprid**—just fleas; in combination products
- **Fipronil**—fleas and ticks
- **Spinosad**—oral; for fleas
- **Spinetoram**—just felines
- Insect growth regulators
  - **Lufenuron, methoprene**
- Isoxazoline derivatives
  - Potential neurological side effects
  - Extralabel use for mange
  - **Fluralaner, lotilaner, sarolaner, afoxolaner**
- Pyrethrins/permethrins (feline toxicity concerns)
- **Amitraz**—only arachnids; not for cats
- **Nitenpyram**—fleas only; 1 day, 30 minutes to effect

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Endo + ectoparasiticides

- Avermectins
  - Issues with MDR1 breeds
  - Treats many nematodes and ectoparasites
  - Mainstay of heartworm preventives
  - Effective in large and small animals
  - Many dosing method options
  - **Ivermectin, selamectin, milbemycin, moxidectin, doramectin, eprinomectin**
- Organophosphates
  - Narrow therapeutic index
  - Cholinesterase inhibitor; antidote available
  - **Trichorfon, coumaphos, haloxon, dichlorvos**

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Heartworm treatment

- AHS recommendations
  - Doxycycline 1 mo. and preventive for 3 mo then
  - Adulticide--melarsomine
    - 3 injections recommended
      - 1 initial treatment, then 2 more (24 hrs. apart) in 1 month
    - Exercise restriction post-treatment important
- "Slow kill" treatment
  - Doxycycline q 3 mo + monthly preventive
  - Often cures, but takes 1-2 years
    - Tissue damage can worsen; may promote treatment resistance

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Sample question

- Which parasiticide is utilized for control of *Dipylidium* and *Taenia spp.*?
  - A. Praziquantel
  - B. Pyrantel
  - C. Pyrethrin
  - D. Milbemycin

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Antimicrobials--general

- -Cidal vs. –static
- Antibiotic resistance concerns
- Withdrawal/withholding times
- Decision-making
  - Culture and sensitivity testing

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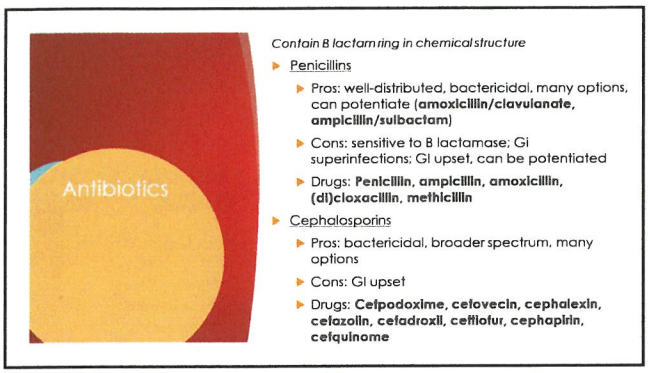

Contain B lactam ring in chemical structure

- Penicillins
  - Pros: well-distributed, bactericidal, many options, can potentiate (**amoxicillin/clavulanate, ampicillin/sulbactam**)
  - Cons: sensitive to B lactamase; GI superinfections; GI upset, can be potentiated
  - Drugs: **Penicillin, ampicillin, amoxicillin, (di)cloxacillin, methicillin**
- Cephalosporins
  - Pros: bactericidal, broader spectrum, many options
  - Cons: GI upset
  - Drugs: **Cefpodoxime, cefovecin, cephalexin, cefazolin, cefadroxil, ceftiofur, cephapirin, cefquinome**

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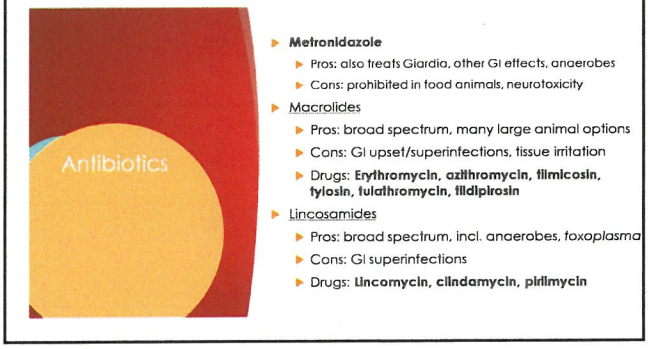

- **Metronidazole**
  - Pros: also treats Giardia, other GI effects, anaerobes
  - Cons: prohibited in food animals, neurotoxicity
- Macrolides
  - Pros: broad spectrum, many large animal options
  - Cons: GI upset/superinfections, tissue irritation
  - Drugs: **Erythromycin, azithromycin, tilmicosin, tylosin, tulathromycin, tildipirosin**
- Lincosamides
  - Pros: broad spectrum, incl. anaerobes, *toxoplasma*
  - Cons: GI superinfections
  - Drugs: **Lincomycin, clindamycin, pirlimycin**

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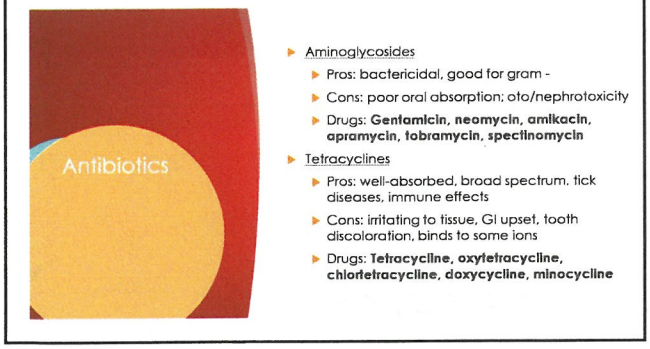

- Aminoglycosides
  - Pros: bactericidal, good for gram -
  - Cons: poor oral absorption; oto/nephrotoxicity
  - Drugs: **Gentamicin, neomycin, amikacin, apramycin, tobramycin, spectinomycin**
- Tetracyclines
  - Pros: well-absorbed, broad spectrum, tick diseases, immune effects
  - Cons: irritating to tissue, GI upset, tooth discoloration, binds to some ions
  - Drugs: **Tetracycline, oxytetracycline, chlortetracycline, doxycycline, minocycline**

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Antibiotics

- Phenicols
  - Pros: Broad spectrum, good for CNS, anaerobes
  - Cons: **Chloramphenicol** prohibited in food animals; possible aplastic anemia
  - Drugs: Also **florfenicol**
- Sulfonamides
  - Pros: broad spectrum, incl. coccidia, can potentiate (add **trimethoprim, ormethoprim**)
  - Cons: vasculitis, KCS, hypersensitivity, skin eruptions, bone marrow suppression, crystalluria
  - Drugs: **Sulfadimethoxine, sulfamethoxazole, sulfamethazine, sulfadiazine, sulfasalazine**
- Fluoroquinolones
  - Pros: broad spectrum, well absorbed, -cidal
  - Cons: not allowed in feed, cartilage damage, CNS toxicity, blindness in cats
  - Drugs: **Enrofloxacin, ciprofloxacin, orbifoxacin, pradofloxacin, danofloxacin**

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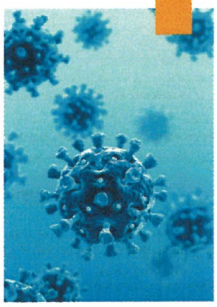
Antivirals

- General comments:
  - Few approved products
  - Usually affect DNA/RNA synthesis
- Nucleoside analogues:
  - Remdesevir/GS-441524
  - Famciclovir, Acyclovir
- Other medications:
  - Lysine, interferon, idoxyuridine



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Fungistatic antifungals

- May require longer-term treatment
- Imidazoles
  - Used for cutaneous and systemic infections
  - May need hepatic monitoring
  - **Fluconazole, itraconazole, ketoconazole, miconazole, enilconazole**
- **Griseofulvin**
  - Mainly for dermatophytes
  - Avoid in pregnant animals; give with a fatty meal

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Fungicidal antifungals

- **Lime sulfur** (topical dip)
- **Terbinafine**—oral, safe
- **Nystatin**—oral, topical

For severe infections:

- **Flucytosine**
  - Nephrotoxic, bone marrow effects, dermatitis
- **Amphotericin B**
  - Nephrotoxic; protect form light

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Antiseptics+disinfectants

- Antiseptics—safe to use on living tissue; disinfectants—used on objects/surfaces
  - Frequently require dilution
- **Chlorhexidine**—good spectrum
- **3% hydrogen peroxide**
  - More likely to irritate tissues
- **Alcohol**—70% for tissue
- **Iodines/iodophors**—good spectrum

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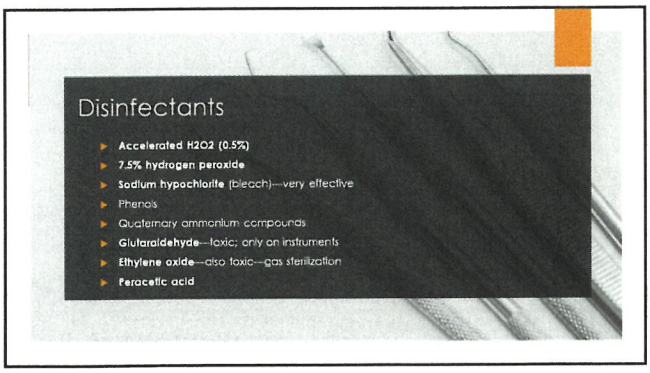

Disinfectants

- **Accelerated H2O2 (0.5%)**
- **7.5% hydrogen peroxide**
- **Sodium hypochlorite** (bleach)—very effective
- Phenols
- Quaternary ammonium compounds
- **Glutaraldehyde**—toxic; only on instruments
- **Ethylene oxide**—also toxic—gas sterilization
- **Peracetic acid**

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Sample question

- Which antibiotic would be least appropriate to administer to a lagomorph?
  - A. Sulfadimethoxine
  - B. Enrofloxacin
  - C. Doxycycline
  - D. Amoxicillin-clavulanate

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Analgesics and anti-inflammatories--terminology

- *Nociceptors*- pain receptors
- *Visceral pain*--from internal organs/body cavities
- *Somatic pain* --from the skin and musculoskeletal system
- *Neuropathic pain*--from injury to the peripheral or central nervous system
- *Analgesia*—lack of pain
- Pain management should be preemptive, and multimodal analgesia should be used when needed
  - *Preemptive*—start meds before painful stimulus
  - *Multimodal*—use more than one analgesic, with differing modes of action
- *Hyperalgesia* is where are of tissue injury becomes more sensitive and pain threshold decreases
- *Wind up* is the perceived increase in pain intensity after certain neurons in the spinal cord are stimulated repeatedly

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Analgesics

- Non-steroidal anti-inflammatories
  - COX 1 effects: platelet function, GI and renal protection
  - COX 2 effects: inflammation and pain
  - Non-selective COX inhibitors
    - **Aspirin, phenylbutzone, flunixin meglumine**
  - COX-2 selective inhibitors
    - **Carprofen, ketoprofen**
    - **Deracoxib, firocoxib, robenacoxib**
    - **Meloxicam, piroxicam**
  - Non-COX-related
    - **Grapiprant**

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Other analgesics

- Opioids
  - Full-Mu agonists: **morphine, hydromorphone, hydrocodone, oxycodone, methadone, fentanyl**
  - Partial Mu agonists: **buprenorphine**
  - Mixed agonist/antagonist: **butorphanol**
  - **Tramadol:** Mu receptor agonist
  - Antagonists: **naloxone, naltrexone**
- Local anesthetics
  - **Lidocaine, bupivacaine, benzocaine, proparacaine, tetracaine**
- Monoclonal antibodies
  - **Frunevetmab, bedinvetmab**
  - Affect nerve growth factor; long-acting injectables

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Glucocorticoids

Anti-inflammatory, immunosuppressive, disrupts histamine

- Tx allergies, auto immune disease, Addison's disease, decreased imflammation

Wide variety of durations and dose forms

- Inhaled: fluticasone
- Topicals: **hydrocortisone, betamethasone, triamcinolone, dexamethasone**
- 12-48 hours: **prednis(ol)one, triamcinolone, dexamethasone, methylprednisolone, budesonide**
- Long-acting injectable: **triamcinolone acetonide, methylprednisolone acetate**

Numerous adverse effects possible

- PU/PD/PP
- Immune suppression, delayed healing
- Cushing's, Addison's, diabetes
- Osteoporosis, muscle atrophy, thin skin
- Ulcers and GI upset

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Antihistamines/atopy medications

- H1 blockers—allergic response/anaphylaxis, motion sickness
  - **Diphenhydramine, chlorpheniramine, hydroxyzine, cetirizine, loratadine, cyproheptadine, dimenhydrinate**
- **Cyclosporine**—immunosuppressant
- **Lokivetmab**—monoclonal antibody against IL31
- **Ilunocitinib**—IL31 antagonist
- **Oclacitinib**—IL31 antagonist

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Other topical medications

- Antiseborrheics
  - For flaky skin
  - Benzoyl peroxide, phytosphingosine, sulfur, salicylic acid
  - Toxic to felines: **selenium sulfide, coal tar**
- Astringents
  - Dries/contracts skin/tissue
  - **"Burow's solution" (aluminum acetate), tea tree oil, acetic/boric acid, salicylic acid, iodine**
- Anti-pruritics/anti-inflammatories
  - **Pramoxine, colloidal oatmeal, phytosphingosine, EFAs, zinc gluconate**
- Counterirritants
  - **Copper sulfate, silver nitrate, camphor/menthol/phenol, alcohol, iodine**
- Cerumenolytics
  - **Squalene, DSS, glycerin, phytosphingosine**

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Sample question

- This treatment for atopy utilizes monoclonal antibodies:
  - A. Loratadine
  - B. Lokivetmab
  - C. Oclactinib
  - D. Cyclophosphamide

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Nervous system medications

- Parasympathetic effects: "rest and digest"
  - Decreased HR/contractility, bronchiolar constriction, miosis, smooth muscle relaxation
- Sympathetic effects: "fight or flight"
  - Dopaminergic
    - Dilates renal, cardiac, mesenteric vessels
  - Alpha 1
    - Arteriolar constriction, dilates pupils, increases urethral tone
  - Alpha 2
    - Inhibits sympathetic activity
  - Beta 1
    - Increases HR, conduction, contractility, renal renin release
  - Beta 2
    - Dilates skeletal blood vessels and bronchioles

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Sympathetic NS (adrenergic) agonists

- Primarily alpha-1
  - Increased cardiac output/HR, increased BP, dilated bronchioles
  - **Epinephrine, norepinephrine**
- Alpha-2
  - Sedation, analgesia; peripheral vasoconstriction and bradycardia
  - **Xylazine, dexmedetomidine**, etc.
- Primarily beta-1
  - Acute management of CHF, renal failure; post CPA treatment
  - **Dobutamine, dopamine**
- Primarily beta-2
  - Bronchodilation
  - **Albuterol, terbutaline, isoproteranol**

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Sympathetic NS (adrenergic) antagonists

- Alpha-1 blockers
  - Vasodilation
  - **Phenoxybenzamine** (also urinary obstruction), **acepromazine** (also sedation), **prazosin**
- Alpha-2 blockers
  - Reversal of alpha-2 agonist effects
  - **Yohimbine, atipamezole**
- Beta blockers
  - Hypotension, bradycardia; treat cardiac arrhythmias
  - **Propranolol, atenolol, metoprolol, timolol** (miosis), etc.

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Parasympathetic NS drugs

- Cholinergic
  - Decrease IOP, increase GI motility and urination, antidote for neuromuscular blockers, diagnose MG
  - Direct—**acetylcholine, bethanechol, pilocarpine**
  - Indirect—**organophosphates, demecarium, neostigmine, pyridostigmine**
- Anticholinergic
  - **Atropine**
    - Preanesthetic, decreases secretions, treats bradycardia and organophosphate toxicity
  - **Glycopyrrolate**
    - Preanesthetic, longer duration
  - **Pralidoxime**
    - Cholinesterase reactivator, for OP toxicity
  - **Propantheline**
    - Treats diarrhea, urinary incontinence, bradycardia

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Anticonvulsants

- **Phenobarbital**—class IV CS
  - Some sedation also; monitor blood levels and liver enzymes
- Benzodiazepines—class IV CS
  - **Diazepam, clorazepate**
- **Potassium bromide**
  - Needs large loading dose, or long time to effect
  - Narrow therapeutic index; usually adjunct therapy
- **Levetiracetam**
  - Initial treatment, or refractory cases
- **Zonisamide**
  - Refractory cases
- **Gabapentin**
  - Usually as an adjunct

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Behavior medications

- Anxiolytics
  - **Gabapentin, pregabalin**
  - Benzodiazepines—**diazepam, alprazolam, clorazepate**
    - **Class IV CS; also sedation, muscle relaxation**
  - **Trazodone**—modulates serotonin
  - **Buspirone**
- Tricyclic antidepressants—separation anxiety, OCD, phobias, aggression, etc.
  - Dry mouth, tachycardia (anticholinergic); side effects
  - **Amitryptyline, clomipramine**
- Serotonin reuptake inhibitors—effects similar to TCAs
  - **Fluoxetine, sertraline, paroxetine**
- Serotonin syndrome
  - When multiple serotonergic drugs are used (or excess of one)
    - Sedation, then agitation, ataxia, tachycardia, hyperthermia, tremors, V/D, etc.
- **Selegiline**—for cognitive dysfunction syndrome

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Sample question

- Which neurotransmitter is associated with parasympathetic receptors?
  - A. Dopamine
  - B. Acetylcholine
  - C. Epinephrine
  - D. Norepinephrine

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Sedatives and anesthetics--terminology

Tranquilization	• To sedate or relieve anxiety by administration of a drug; patient is conscious but may be indifferent to mild pain
Sedation	• More pronounced tranquilization; patient may have notable CNS depression
Analgesia	• Loss of sensitivity to pain—may or may not be associated with sedation/loss of consciousness
Anesthesia	• Total loss of sensation in a part of or the whole body, usually by administration of a drug which causes local or general depression of nervous tissue activity

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Sedatives/ tranquilizers

- Phenothiazines
  - Widely used; no analgesia, broad dose range
  - Hypotension, bradycardia, poor thermoregulation, penile prolapse (stallion), prolapsed nictitating membrane
  - **Acepromazine, chlorpromazine**
- Benzodiazepines
  - Anxiolytic, muscle relaxation, seizure control; minimal cardiac depression
  - **Diazepam, midazolam, alprazolam**
  - **flumazenil** reversal
- Alpha 2 agonists
  - **Xylazine, dexmedetomidine, detomidine, romifidine**
  - **Yohimbine, atipamezole** reversal
- Barbiturates--uncommon
  - Also euthanasia drugs--**pentobarbital**
- Dissociatives
  - Catalepsy, amnesia, mild analgesia; painful
  - **Ketamine; tiletamine** (+zolazepam)
- Opioids (see analgesic section)

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Anesthetic agents

- Halogenated inhalent anesthetics
  - Fast acting, minimal metabolism, primarily respiratory excretion
  - **Isoflurane, sevoflurane (enflurane, halothane)**
- Local anesthetics—use alone or as adjuncts
  - **Lidocaine, bupivacaine, mepivacaine, proparacaine**
- Injectable general anesthetics
  - **Propofol**—very short acting (can do CRI); pronounced respiratory depression
  - **Alfaxalone, etomidate**--short acting injectables, few adverse effects
- Neuromuscular blocking agents
  - Muscle relaxation/paralysis
  - **Succinycholine, d-tubocurare**

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Sample question

- This dissociative anesthetic can be used for control of wind-up pain:
  - A. Acepromazine
  - B. Dexmedetomidine
  - C. Buprenorphine
  - D. Ketamine

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Endocrine drugs--reproductive

- Gonadotropins
  - Uses: cycle regulation, cystic ovary treatment
  - Concerns: pregnant women should avoid
  - Drugs: **Gonadorelin, chorionic gonadotropin, follicle-stimulating hormone (FSH)**
- Progestins
  - Uses: treat behavior problems; estrus suppression
  - Concerns: increased endometrial/mammary secretions, increases blood glucose
  - Drugs: **Megestrol acetate, medroxyprogesterone acetate, altrenogest**
- Prostaglandins
  - Uses: mainly estrus synchronization
  - Concerns: bronchoconstriction, uterine contractions, hypertension
  - Drugs: **Dinoprost, cloprostenol**
- **Oxytocin**
  - Uses: milk let-down, uterine contractions

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Reproductive medications

- Estrogens
  - Uses: incontinence, mismating, estrus induction; growth promotion (livestock)
  - Concerns: abortion, pyometra, cysts, anemia
  - Drugs: **Estradiol cypionate, estriol, diethyistilbestrol**
- Androgens
  - Uses: anabolism, wt. gain, (including growth promotion in livestock); improved fertility
  - Concerns: misuse
  - Drugs: **(Methyl)testosterone, boldenone, mibolerone, nandrolone, stanzolol**

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Adrenal medications

Hypoadrenocorticism

- Mineralocortioids
  - **Fludricortisone, DOCP (desoxycorticosterone pivalate)**
- Glucocorticoids
  - **Prednisolone**

Hyperadrenocorticism

- **Ketoconazole**
- **Mitotane**
- **Trilostane**
- **Selegiline**

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Thyroid medications

- Hypothyroidism
  - **Levothyroxine**
    - Synthetic thyroid hormone replacement
    - Overdose can cause symptoms of hyperthyroidism
- Hyperthyroidism
  - Overdose of treatment can lead to signs of hypothyroidism
  - **Methimazole**
    - Interferes with incorporation of iodine into thyroid hormone
  - **Y/D diet**
  - **Radioactive iodine**
    - Destroys overactive thyroid tissue

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Pancreatic medications

- Diabetes mellitus
  - Insulin—understand general handling of products!
    - Short-acting: **regular insulin**
    - Intermediate-acting: **NPH, PZI, lente insulin**
    - Long-acting: **glargine, detemir, ultralente insulin**
  - SGLT2 inhibitors
    - Prevent renal resorption of glucose
    - **Sexagliflozin, Velaglifozin**
- Insulinoma
  - **Prednisolone** (glucocorticoids)

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Sample question

- Which type of insulin is preferred for glycemic control in a ketoacidotic diabetic animal?
  - A. Protamine zinc insulin
  - B. Glargine insulin
  - C. Regular insulin
  - D. NPH insulin

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Cardiovascular drugs--terminology

- *Heart rate*: number of beats/minute
- *Cardiac output*: the amount of blood that the heart can pump per minute
  - CO = SV x HR (SV = stroke volume; HR = heart rate)
  - Determined by preload, afterload, contractility, rate, distensibility, synergy of contraction
- *Preload*: stretching of myocardial cells during diastole; affected by the amount of blood that fills the ventricle in diastole (filling of the heart)
- *Afterload*: the arterial resistance against which the ventricle must pump in systole (distribution of blood)
- *Contractility*: ability of myocardium to squeeze/pump
- *Chronotropes*: drugs that alter the heart rate
- *Inotropes*: drugs that alter the force of contraction

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Anti-arrhythmics

- Class 1 drugs--sodium blockers
  - **Quinidine, procainamide**
  - **Lidocaine, Tocainide**
- Class 2 drugs--beta blockers
  - **Propranolol, atenolol, carvedilolol, metoprolol**
- Class 3 drugs--potassium blockers
  - **Amiodarone, bretylium**
  - Uncommon in vet med
- Class 4 drugs--calcium blockers/relax coronary arteries
  - **Amlodipine, nifedipine**
    - Also for hypertension
  - **Verapamil**
  - **Diltiazem**

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Positive inotropes

- Bipyridine derivatives
  - Increase cellular calcium
  - **Amrinone** (Inocor); **Milrinone**
- Catecholamines–related to naturally-occurring sympathetic neurotransmitters
  - Increase heart rate, contractility, blood pressure
  - Used for resuscitation or short-term management of CHF
  - **Epinephrine, Isoproteranol, Dopamine, Dobutamine**
- Cardiac glycosides
  - **Digitalis/digoxin**
  - Affect calcium; narrow therapeutic index
- **Pimobendan** ("Vetmedin"; chewable tablets)
  - Like a combination of a positive inotrope and a vasodilator (improved contractility and decreased afterload)

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Diuretics

Loop (of Henle) diuretics
- **Furosemide, torasemide**
- Very effective; pronounced PU/PD; possible hypokalemia

Thiazides
- **Chlorothiazide, hydrochlorothiazide**
- For refractory cases; less PU/PD but may vasodilate

Carbonic anhydrase inhibitors
- **Acetazolamide, dichlorphenamide, dorzolamide**
- Weak renal effects (better for IOP reduction)

Potassium-sparing (antagonizes aldosterone)
- **Spironolactone**
- **Cardalis—combined with benazepril**

Osmotic
- **Mannitol**—for acute/emergent situtions

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Vasodilators

- Angiotensin-converting enzyme (ACE) inhibitors
  - Decreases afterload and preload; monitor renal function
  - **Enalapril, benazepril, captopril**
- Other vasodilators
  - **Telmisartan**—feline hypertension
  - **Prazosin**
  - **Isoxuprine**—for equine hoof diseases
  - **Sildenafil**—pulmonary hypertension
  - **Hydralazine**—arteriolar dilator
  - **Nitroglycerin**—for acute CHF, rapid decrease in preload
  - **Nitroprusside**-for acute hypertension

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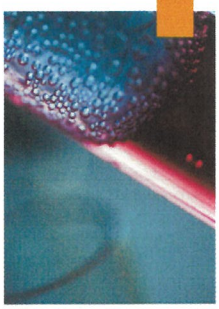
Drugs affecting clotting

- Anticoagulants
  - Aspirin--caution--NSAID side effects
  - Heparin--in vitro or in vivo
- Clot destruction
  - Clopidogel
    - Acute use, or prophylactically
- Hemostatic drugs
  - External--styptic powder, silver nitrate
  - Internal--biodegradable sponges/pads/powders



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Sample question

- This cardiac medication exhibits both positive inotropic and vasodilatory effects
  - A. Epinephrine
  - B. Pimobendan
  - C. Benazepril
  - D. Nitroglycerin

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Respiratory drugs--terminology

Respiration	• Gas exchange within the body • External or internal
Ventilation	• Movement of air in and out • Facilitated by diaphragm
Distribution	• Dissemination of inspired gas through the lungs
Diffusion	• Movement of gas across the alveolar membrane
Perfusion	• Blood supply to alveoli. Ratio of ventilation to perfusion is usually about 1:1

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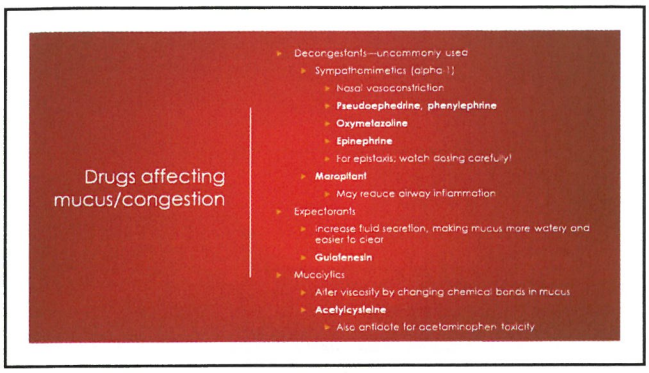
Drugs affecting mucus/congestion
Decongestants—uncommonly used
Sympathomimetics (alpha 1)
Nasal vasoconstriction
Pseudoephedrine, phenylephrine
Oxymetazoline
Epinephrine
For epistaxis; watch dosing carefully!
Maropitant
May reduce airway inflammation
Expectorants
Increase fluid secretion, making mucus more watery and easier to clear
Guaifenesin
Mucolytics
Alter viscosity by changing chemical bonds in mucus
Acetylcysteine
Also antidote for acetaminophen toxicity

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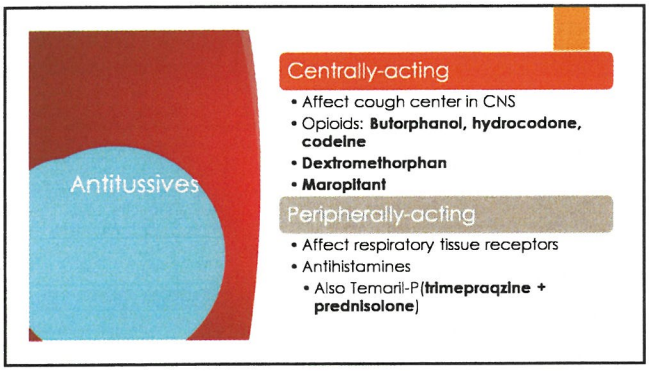
Antitussives
Centrally-acting
• Affect cough center in CNS
• Opioids: Butorphanol, hydrocodone, codeine
• Dextromethorphan
• Maropitant
Peripherally-acting
• Affect respiratory tissue receptors
• Antihistamines
• Also Temaril-P(trimepraqzine + prednisolone)

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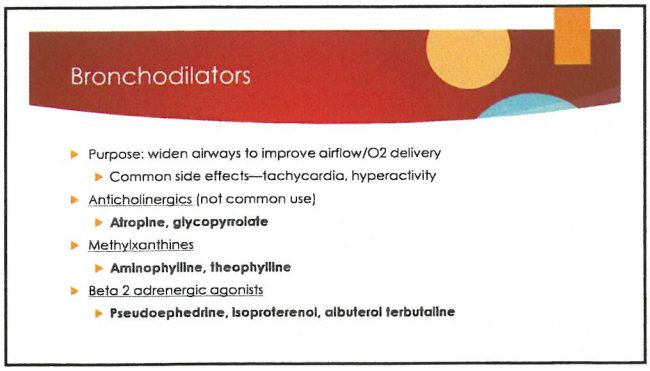
Bronchodilators
Purpose: widen airways to improve airflow/O2 delivery
Common side effects—tachycardia, hyperactivity
Anticholinergics (not common use)
Atropine, glycopyrrolate
Methylxanthines
Aminophylline, theophylline
Beta 2 adrenergic agonists
Pseudoephedrine, isoproterenol, albuterol terbutaline

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Other respiratory medications

- Antihistamines
  - Block histamine release, prevent bronchoconstriction
- Glucocorticoids
  - Relieve chronic inflammation
- Respiratory stimulants
  - Doxapram--centrally acting
- Mast cell stabilizers
  - Cromolyn (for equine heaves)

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Sample question

- This antitussive is also a controlled substance:
  - A. Butorphanol
  - B. Dextromethorphan
  - C. Trimeprazine
  - D. Maropitant

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Gastrointestinal drugs—appetite stimulants

- **Cyproheptadine**
  - Antihistamine, increased appetite as side effect
- **Mirtazepine**
  - Antidepressant that also improves appetite
- **Capromorelin**
  - Hunger hormone receptor agonist
- **Vitamins B12 and B6**
- Anabolic steroids--seldom used--abuse potential
- **Diazepam**
  - Anxiolytic; side effect of increased hunger

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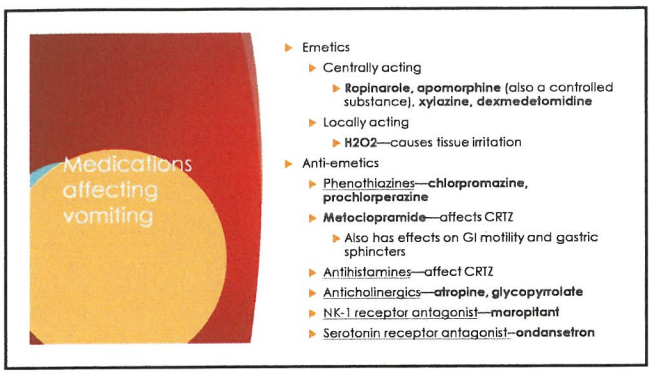
Medications affecting vomiting
Emetics
Centrally acting
Ropinarole, apomorphine (also a controlled substance), xylazine, dexmedetomidine
Locally acting
H2O2—causes tissue irritation
Anti-emetics
Phenothiazines—chlorpromazine, prochlorperazine
Metoclopramide—affects CRTZ
Also has effects on GI motility and gastric sphincters
Antihistamines—affect CRTZ
Anticholinergics—atropine, glycopyrrolate
NK-1 receptor antagonist—maropitant
Serotonin receptor antagonist--ondansetron

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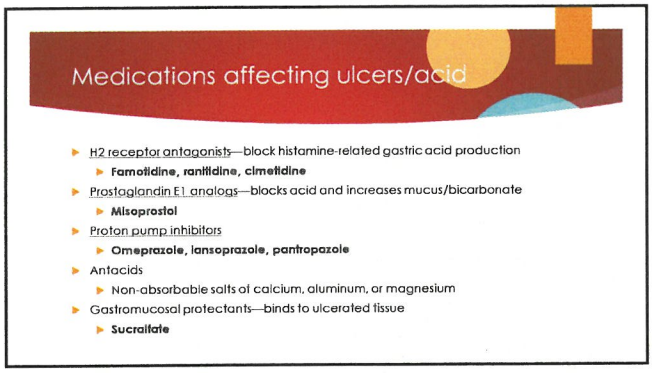
Medications affecting ulcers/acid
H2 receptor antagonists—block histamine-related gastric acid production
Famotidine, ranitidine, cimetidine
Prostaglandin E1 analogs—blocks acid and increases mucus/bicarbonate
Misoprostol
Proton pump inhibitors
Omeprazole, lansoprazole, pantropazole
Antacids
Non-absorbable salts of calcium, aluminum, or magnesium
Gastromucosal protectants—binds to ulcerated tissue
Sucralfate

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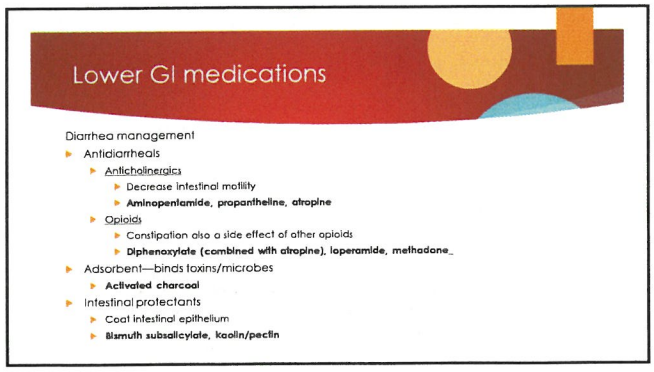
Lower GI medications
Diarrhea management
Antidiarrheals
Anticholinergics
Decrease intestinal motility
Aminopentamide, propantheline, atropine
Opioids
Constipation also a side effect of other opioids
Diphenoxylate (combined with atropine), loperamide, methadone
Adsorbent—binds toxins/microbes
Activated charcoal
Intestinal protectants
Coat intestinal epithelium
Bismuth subsalicylate, kaolin/pectin

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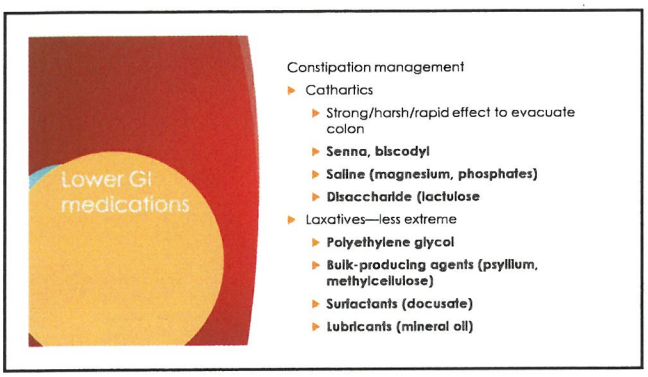
Lower GI medications
Constipation management
Cathartics
Strong/harsh/rapid effect to evacuate colon
Senna, bisacodyl
Saline (magnesium, phosphates)
Disaccharide (lactulose
Laxatives—less extreme
Polyethylene glycol
Bulk-producing agents (psyllium, methylcellulose)
Surfactants (docusate)
Lubricants (mineral oil)

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Prokinetics and other GI drugs
GI prokinetics
Increase transit through GI tract
Metoclopramide (dopamine antagonist)
Cisapride (serotonergic)
Erythromycin (at low doses)
Cholinergics
Anti-foaming agents (for frothy bloat)
Mineral oil, poloxalene
Pancreatic enzymes
Dried porcine pancreas powder
Fuzapladib
Monoclonal antibody for pancreatitis management
CPMA—canine parvovirus monoclonal antibody

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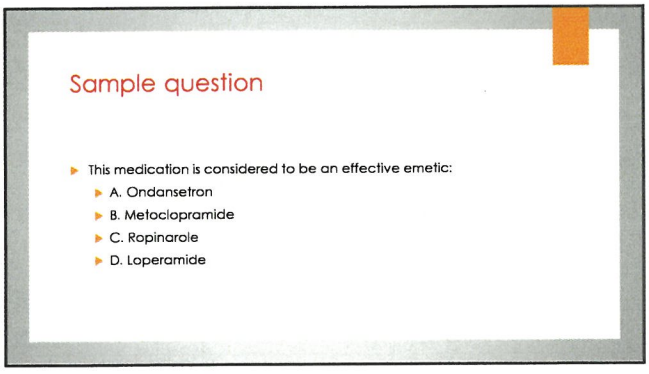
Sample question
This medication is considered to be an effective emetic:
A. Ondansetron
B. Metoclopramide
C. Ropinarole
D. Loperamide

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Urinary tract drugs--general

All were discussed in cardiac drugs

Primary use in renal disease is to decrease blood pressure

- Diuretics
- Angiotensin 2 converting enzyme (ACE) inhibitors
- Vasodilators
- Calcium channel blockers
- Beta blockers

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Renal disease medications

- **Antidiuretic hormone**
  - Prevents diuresis; used to treat diabetes insipidus
- Erythropoietin analogs
  - Help to minimize anemia
  - **Moludistat, epoietin alpha**
- Phosphate binders
  - **Chitosan/calcium carbonate, aluminum hydroxide**
- Appetite stimulants
  - In GI drugs

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Cystitis and calculi management

Glycosaminoglycans, etc

Urinary acidifiers

- Help dissolve and prevent struvite uroliths
- **Methionine, ammonium chloride**

Urinary alkalinizers

- Help prevent calcium oxalate, cystine, ammonium urate uroliths
- **Potassium citrate, sodium bicarbonate; allopurinol** (decreases uric acid)

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Management of urination

- Treatment of incontinence
  - Estrogens: **Diethylstilbestrol (DES), estriol**
    - Make urethral muscles more receptive to stimulation
  - Sympathomimetics: **Phenylpropanolamine, ephedrine**
    - Side effects hyperactivity, increased HR and BP
- Treatment of urine retention
  - Muscle relaxant: **baclofen**
  - Parasympathomimetic: **bethanecol**
    - Increased bladder contractility
  - Alpha adrenergic antagonist: **phenoxybenzamine**
    - Decreased sphincter tone

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Sample question

- Which medication would be most appropriate for treating hypertension associated with renal failure?
  - A. Vasopressin
  - B. Phenylpropanolamine
  - C. Benazepril
  - D. Acetazolamide

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Immunosuppressants

- Glucocorticoids—at high doses
  - Esp. **prednisone, dexamethasone, budesonide**
- **Azathioprine**—not in cats; suppresses B and T cells
- **Cyclosporine**—inhibits T cells
- **Tacrolimus/pimecrolimus/sirolimus**—topical; compounded
- **Mycophenolate**—B and T cell suppressor
- **Cyclophosphamide**—also chemotherapeutic; significant side effects
- **Metronidazole**—more for inflammatory GI diseases
- **Tetracyclines**—weak immunosuppressors; in combo with other drugs

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Chemotherapy drugs

- General principles
  - Affect rapidly dividing cells (also cause of side effects)
  - Maximum tolerated dose vs. metronomic therapy
  - Combination therapy to reduce side effects; use BSA to calculate dose
  - Staff (and client) safety concerns
- Drugs affecting cell cycle
  - Vesicants (very irritating to tissue)
    - **Vincristine, vinblastine, doxorubricin, dactinomycin**
  - Others
    - Oral
      - **Azathioprine, methotrexate, chlorambucil, lomustine**
    - Injectable
      - **Azathioprine, methotrexate, cytosine, bleomycin, cisplatin, mitoxantrone**
      - **5-fluouriacil (also topical creams for humans—highly toxic)**

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Additional chemotherapy medications

- Benzimidazoles?—in vitro anti-cancer effects
- **Asparginase**—breaks down amino acids
- **Prednisolone**—palliative, or in combinations
- **Toceranib**—antiproliferative; approved for mast cell tumors
- **Tiglianol**—destroys MCT cell walls and vasculature
- **Paclitaxel**—inhibits cell division
- **Rabaclosadine**—for canine lymphoma; disrupts DNA synthesis
- **Phenylthiazole**—for canine lymphoma—affects proteins
- Monoclonal antibodies—very specific

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Sample question

- Which immunosuppressant would be most likely to cause polyuria and polydipsia?
  - A. Cyclophosphamide
  - B. Dexamethasone
  - C. Torasemide
  - D. Tacrolimus

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Nutraceuticals

- General thoughts
  - Safety, efficacy
- **SAM-e/silymarin/milk thistle**—liver support
- **Fatty acids**—anti-inflammatory
- **Coenzyme Q10**—cell energy (esp. cardiac)
- **L-carnitine**—cell metabolism
- **Glutathione**—tissue/immune support
- Antioxidants—general tissue protection
- Joint supplements
  - **Glucosamine, chondroitin, hyaluronic acid, green-lipped mussel extract, MSM**
- Prebiotics—food for good gut microbes
- Probiotics-actual good microbes

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Sample question

- Supplements for patients with joint disease would be most likely to contain this nutraceutical:
  - A. Milk thistle extract
  - B. Coenzyme Q10
  - C. Glutathione
  - D. Glucosamine

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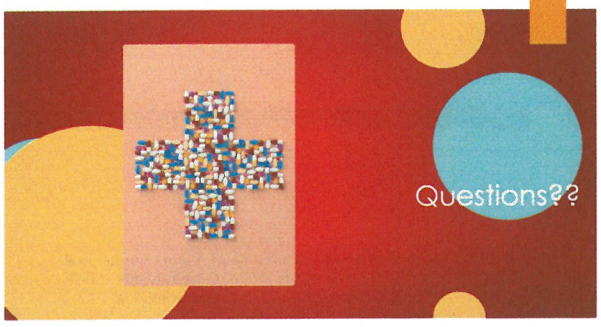

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