When the bacterial cell wall is impaired, the cell is rapidly broken down and destroyed.

Specific Administration Considerations: In addition to general antimicrobial administration considerations, it is important to monitor patients who receive penicillins for signs of superinfections such as C-diff or yeast infections. There is also a cross-sensitivity for patients allergic to cephalosporins. It is important to remember that patients who are prescribed high doses of penicillin may experience significant coagulation abnormalities.

Other notable drug interactions include the use of diuretic therapy with penicillin. Penicillin contains a significant amount of potassium. Patients receiving potassium-sparing diuretics or supplementation should be monitored for signs of hyperkalemia. Penicillin is best absorbed on an empty stomach; however, many patients may experience GI upset and subsequently take the medication with food.

Patient Teaching & Education: The patient should notify the health care provider (HCP) if fever or diarrhea develops, especially if the stool contains blood, pus, or mucus. Advise the patient not to treat diarrhea without advice from HCP. If GI upset occurs, the patient may take the medication with meals but should avoid taking with citrus-based products, which can impede absorption. Additionally, patients should be instructed to chew oral chewable tablets thoroughly before swallowing. The patient should report a rash or any signs of superinfection (black, furry overgrowth on tongue; vaginal itching or discharge; loose or foul-smelling stool).

Patients should be instructed to take medication around the clock and to finish the drug completely as directed. Doses should be spaced evenly to achieve the desired therapeutic effect. Additionally, patients should receive instruction to not share medication and that any sharing of medications may be dangerous. Patients with a history of rheumatic heart disease or valve replacement should receive instruction regarding the importance of using antimicrobial prophylaxis before invasive medical or dental procedures. Female patients taking oral contraceptives should use an alternative form of contraception during therapy with amoxicillin and until next period. Patients should notify their HCP if symptoms do not improve.

Now let's take a closer look at the penicillin medication grid in Table 3.5.

Medication grids are intended to assist students to learn key points about each medication. Basic information related to a common generic medication in this class is outlined, including administration considerations, therapeutic effects, and side effects/adverse effects. **Prototype**/generic medications listed in the medication grid are also hyperlinked directly to a free resource from the United States National Library of Medicine called Daily Med. Because information about medication is constantly changing, nurses should always consult evidence-based resources to review current recommendations before administering specific medication. On the home page of Daily Med, enter the drug name in the search bar to read more about the medication.

Table 3.5 Penicillin Medication Grid

Class/	Prototype-Generic	Administration	Therapeutic	Side/Adverse Effects

Subclass		Considerations	Effects	
Penicillin	penicillin V (PO) penicillin G (IV) amoxicillin piperacillin/tazobactam (combination product)	Check for allergies to penicillin or cephalosporins Obtain culture, if ordered, before first dose Take w/ full glass of water; no acidic juice Best absorbed orally on empty stomach; give with food if stomach upset If high doses; monitor INR, platelets, PT	Monitor for systemic signs of infection: -WBCs -Temp -Culture results Monitor actual site of infection for improvement	Common: nausea, vomiting, epigastric distress, diarrhea, and black hairy tongue Monitor for C-diff, candidiasis, and hyperkalemia Hypersensitivity: Rash (maculopapular to exfoliative dermatitis), urticaria, laryngeal edema, and anaphylaxis SAFETY: If an allergic reaction occurs, penicillin should be discontinued and appropriate therapy instituted. Serious anaphylactic reactions require emergency treatment with epinephrine and airway management

Critical Thinking Activity 3.5a

Using the above grid information, consider the following clinical scenario question:

Mr. Jones was admitted to the medical surgical floor with a Pneumococcal respiratory infection and prescribed penicillin V 500 mg PO every 6 hours. You bring the patient his 0800 medications, which include his penicillin. The patient has just finished his breakfast that included orange juice. Would you proceed with the penicillin administration at this time? Why or why not?

Note: Answers to the Critical Thinking activities can be found in the “Answer Key” sections at the end of the book.

3.7 Carbapenems

Open Resources for Nursing (Open RN)

Carbapenems are a beta- lactam "cousin" to penicillins and cephalosporins.

Indications: Carbapenems are useful for treating life-threatening, multidrug-resistant infections due to their broad spectrum of activity.
Papp-Wallace, K. M., Endimiani, A., Taracila, M. A., & Bonomo, R. A. (2011). Carbapenems: past, present, and future. *Antimicrobial agents and chemotherapy, 55*(11), 4943–4960. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3195018/
These antibiotics are effective in treating gram-positive and gram-negative infections. Because of their broad spectrum of activity, these medications can be especially useful for treating complex hospital-acquired infections or for patients who are immunocompromised.

Mechanism of Action: Carbapenems are typically bactericidal and work by inhibiting the synthesis of the bacterial cell wall.

Specific Administration Considerations: Carbapenems are similar to cephalosporins. Cross sensitivity may occur in patients allergic to pencillin or cephalosporins.

Patient Teaching & Education: Patients should monitor for signs of superinfection and report any occurrence to the provider. If a patient experiences fever and bloody diarrhea, they should contact the provider immediately. The patient should also be advised that side effects can occur even weeks after the medication is discontinued.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for imipenem in Table 3.7.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019.

Table 3.7 Carbapenem Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Carbapenems	imipenem	Route: IV Check for allergies, including penicillin and cephalosporins Dosage adjustment if renal impairment Use with caution with seizure disorder or renal dysfunction	Monitor for systemic signs of infection: -WBCs -Fever Monitor actual site of infection Monitor culture results, if obtained	Similar to cephalosporins

Critical Thinking Activity 3.7a

Using the above grid information, consider the following clinical scenario question:

John Smith was admitted to the hospital with a serious abdominal infection. The nurse notices that this patient is allergic to penicillin as he prepares to administer the first dose of imipenem medication. What is the nurse's next best action?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.8 Monobactams

Open Resources for Nursing (Open RN)

Like penicillins, cephalosporins, and carbapenems, monobactams also have a beta-lactam ring structure.

Indications: Monobactams are narrow-spectrum antibacterial medications that are used primarily to treat gram-negative bacteria such as Pseudomonas aeruginosa.

Mechanism of Action: Monobactams are bactericidal and work to inhibit bacterial cell wall synthesis. This work is a derivative of Microbiology by OpenStax licensed under CC BY 4.0. Access for free at https://openstax.org/books/microbiology/pages/1-introduction

Specific Administration Considerations: Patients taking monobactams may experience adverse effects similar to other beta-lactam medications, so nurses should monitor for GI symptoms, skin sensitivities, and coagulation abnormalities.

Patient Teaching & Education: Patients should monitor for signs of superinfection and report any occurrence to the provider. If the patient experiences fever and bloody diarrhea, they should contact the provider immediately. The patient should also be advised to notify the provider immediately if symptoms progress or if any sign of allergic response occurs.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for aztreonam in Table 3.8.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019.

Table 3.8 Monobactam Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Monobactams	aztreonam	Check for allergies to any beta lactams – penicillin, cephalosporins, or carbapenems	Monitor for systemic signs of infection:	Similar to cephalosporins

Can be administered IM, IV, or via inhalation	-WBCs -Fever Monitor actual site of infection Monitor culture results, if obtained

Critical Thinking Activity 3.8a

Using the above grid information, consider the following clinical scenario question:

A patient with cystic fibrosis is diagnosed with ventilator-associated pneumonia and is prescribed Aztreonam 1 gm IV daily for a suspected Pseudomonas aeruginosa infection. The nurse reviews the culture results that just arrived and notices that the results indicate the infection is caused by Methicillin-resistant Staphylococcus aureus. Will this medication be effective against this bacteria? What is the nurse's next best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.9 Sulfonamides

Open Resources for Nursing (Open RN)

Sulfonamides are one of the oldest broad-spectrum antimicrobial agents that work by competitively inhibiting bacterial metabolic enzymes needed for bacterial function.

Indications: Sulfonamides are used to treat urinary tract infections, otitis media, acute exacerbations of chronic bronchitis, and travelers' diarrhea.

Mechanism of Action: This mechanism of action provides bacteriostatic inhibition of growth against a wide spectrum of gram-positive and gram-negative pathogens.

Specific Administration Considerations: Allergic reactions to sulfonamide medications are common and, therefore, patients should be monitored carefully for adverse effects including delayed hypersensitivity reactions. Sulfonamide medications increase the risk of crystalluria that can cause kidney stones or decreased kidney function; therefore, patients should increase their water intake while taking these medications.

Patient Teaching & Education: The patient should receive education to complete the full prescribed dose of medications and take measures to not skip doses. If a dose is missed, the patient should take the missed dose as soon as possible unless it is near the next dosing time. The medication can cause increased photosensitivity, and patients should be educated to use sunscreen and protective clothing with sun exposure. The patient should also report any rash, sore throat, fever, or mouth sores that might occur. Unusual bleeding or bruising should also be reported to the provider. If patients are receiving prolonged therapy, they may require platelet count monitoring.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for trimethoprim-sulfamethoxazole in Table 3.9.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.9 Sulfonamides Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Sulfonamides	trimethoprim – sulfamethoxazole	Check for allergies Dose adjustment for renal impairment Administer PO with 8 oz of water Monitor urine output and for cloudiness or crystals Do not administer IM Use cautiously with cardiac antidysrhythmics Use cautiously with oral antidiabetics; may increase hypoglycemic effects. Monitor glucose level carefully Use cautiously with anticoagulant medications such as warfarin; may increase risk of bleeding. Monitor INR and patient for signs of bleeding	Monitor for systemic signs of infection: -WBCs -Fever Monitor actual site of infection Monitor culture results, if obtained	SAFETY: Sulfonamides, including sulfonamide-containing products such as sulfamethoxaole /trimethoprim, should be discontinued at the first appearance of skin rash of any sign of adverse reaction

Critical Thinking Activity 3.9a

Using the above grid information, consider the following clinical scenario question:

A nurse is caring for an elderly diabetic patient who has been prescribed trimethoprim-sulfamethoxazole for a urinary tract infection. What nursing interventions will be implemented prior to medication administration?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.10 Fluoroquinolones

Open Resources for Nursing (Open RN)

Indications: Fluoroquinolones may be used to treat pneumonia or complicated skin or urinary tract infections.

Mechanism of Action: Fluoroquinolones are a synthetic antibacterial medication that work by inhibiting the bacterial DNA replication. They are bacteriocidal due to the action they take against the DNA of the bacterial cell wall. Many fluoroquinolones are broad spectrum and effective against a wide variety of both gram-positive and gram-negative bacteria.

Specific Administration Considerations: Patients taking oral fluoroquinolones should avoid the use of antacid medication as antacids significantly impede absorption. Patients should also be instructed to take oral fluoroquinolones with a full glass of water two hours before or after meals to enhance absorption and prevent crystalluria. Fluoroquinolone therapy is contraindicated in children except for complicated UTIs, pyelonephritis, plague, or post Anthrax exposure and should be used cautiously in pregnancy.

Black Box Warning: Black Box Warnings are the strongest warnings issued by the Federal Drug Association (FDA) and signify that the medical studies have indicated that the drug carries a significant risk of serious or life-threatening adverse effects.

Fluoroquinolones, including levofloxacin, have been associated with disabling and potentially irreversible serious adverse reactions, including:

- Tendinitis and tendon rupture
- Peripheral neuropathy
- Central nervous system effects
- Exacerbation of muscle weakness in patients with myasthenia gravis

In patients who experience any of these serious adverse reactions, discontinue the medication immediately, and avoid the use of fluoroquinolones.

Patient Teaching & Education: All patients on fluoroquinolone therapy should be instructed to avoid direct and indirect sunlight due to the photosensitivity that can be experienced while on these medications. The patient should take measures to ensure that dosages are spaced evenly throughout the day and that fluid balance is maintained. It is important to maintain an intake of 1500mL-2000mL per day while taking the medication. The patient should be advised that medications containing calcium, aluminum, iron, or zinc may impair absorption and should be avoided. Other side effects of fluoroquinolones increase drowsiness. Additionally, the patient should be cautioned to monitor for episodes of fainting or decreased heart rate and report any history of prolonged QT syndrome. If a patient notices peripheral neuropathy occurring, this should be reported to the healthcare provider. Additional side effects to monitor include increased tendon pain, jaundice, rash, or mood changes.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for levofloxacin in Table 3.10.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.10 Fluoroquinolone Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Fluoroquinolones	levofloxacin	Check for allergies Give with plenty of fluids Oral: Administer 2 hours before or after meals, antacid, or iron IV: Infuse 500 mg or less over 60 minutes and doses of 750 mg over 90 minutes Dosage adjustment if renal or hepatic impairment Use cautiously if history of seizures	Monitor for systemic signs of infection: -WBCs -Fever Monitor actual site of infection Monitor culture results, if obtained	Discontinue immediately if tendonitis, tendon rupture, peripheral neuropathy, CNS effects, or muscle weakness in patients with Myasthenia Gravis Monitor for: -GI upset -Hypersensitivity -Photosensitivity -Hypoglycemia -C-diff

Critical Thinking Activity 3.10a

Utilizing the above grid information, consider the following clinical scenario question:

A nurse is administering levofloxacin to a patient diagnosed with pneumonia. The patient reports that he has pain "above his heel" today. The nurse assesses and discovers the pain is over the Achilles tendon. What is the nurse's next best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.11 Macrolides

Open Resources for Nursing (Open RN)

Macrolides are complex antibacterial broad-spectrum medications that are effective against both gram-positive and gram-negative bacteria.

Mechanism of Action: Macrolides inhibit RNA protein synthesis and suppress reproduction of the bacteria. Macrolides are bacteriostatic as they do not actually kill bacteria, but inhibit additional growth and allow the body's immune system to kill the offending bacteria.

Indications: Macrolides are often used for respiratory infections, otitis media, pelvic inflammatory infections, and Chlamydia.

Specific Administration Considerations: Macrolides can have significant impact on liver function and should be used cautiously in patients with liver disease or impairment.

Patient Teaching & Education: GI upset is common and patients can be advised to take medication with food. Patients should also be advised to avoid excessive sunlight and to wear protective clothing and use sunscreen when outside, as well as to report any adverse reactions immediately. Advise patients to report symptoms of chest pain, palpitations, or yellowing of eyes or skin. Additionally, patients should be advised that these medications can cause drowsiness.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for erythromycin and azithromycin in Table 3.11.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 28, 2019.

Table 3.11 Macrolides Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Macrolides	erythromycin	Check for allergies	Monitor	GI upset

			Hypersensitivity Photosensitivity
azithromycin	PO: Reconstitute suspension with water. Can be given with or without food. Take with food if GI upset occurs IV: Reconstitute and shake until well dissolved. Dilute as instructed. Infuse a 500-mg dose of azithromycin IV over 1 hour or longer. Never give as a bolus or IM injection May prolong QT interval segment. Monitor for dysrhythmias	for systemic signs of infection: -WBCs -Fever Monitor actual site of infection	Discontinue immediately if: -QT prolongation or dysrhythmias -Signs of liver damage or jaundice -Onset or worsening of myasthenia gravis

Critical Thinking Activity 3.11a

Using the above grid information, consider the following clinical scenario question:

A nurse is administering azithromycin to a patient with an acute bacterial worsening of COPD. Today the patient's sclera appear yellow, which is a new finding. What is the nurse's next best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.12 Aminoglycosides

Open Resources for Nursing (Open RN)

Aminoglycosides are a potent broad spectrum of antibiotics that are useful for treating severe infections. Many aminoglycosides are poorly absorbed in the GI tract; therefore, the majority are given IV or IM. Aminoglycosides are potentially nephrotoxic and neurotoxic. They should be administered cautiously. Blood peak and trough levels should be performed to titrate a safe dose for each patient.

Indications: Streptomycin is used for streptococcal endocarditis and a second line treatment for tuberculosis. Neomycin is used in the treatment of hepatic encephalopathy as adjunct therapy to lower ammonia levels and is also used as a bowel prep for colon procedures.

Mechanism of Action: Aminoglycosides are bactericidal and bind with the area of the ribosome known as the 30S subunit, inhibiting protein synthesis in the cell wall and resulting in bacterial death (see Figure 3.9).

Aminoglycosides may be given with beta-lactam medications to facilitate transport of aminoglycoside across the cellular membrane, resulting in a synergistic effect and increasing drug effectiveness.

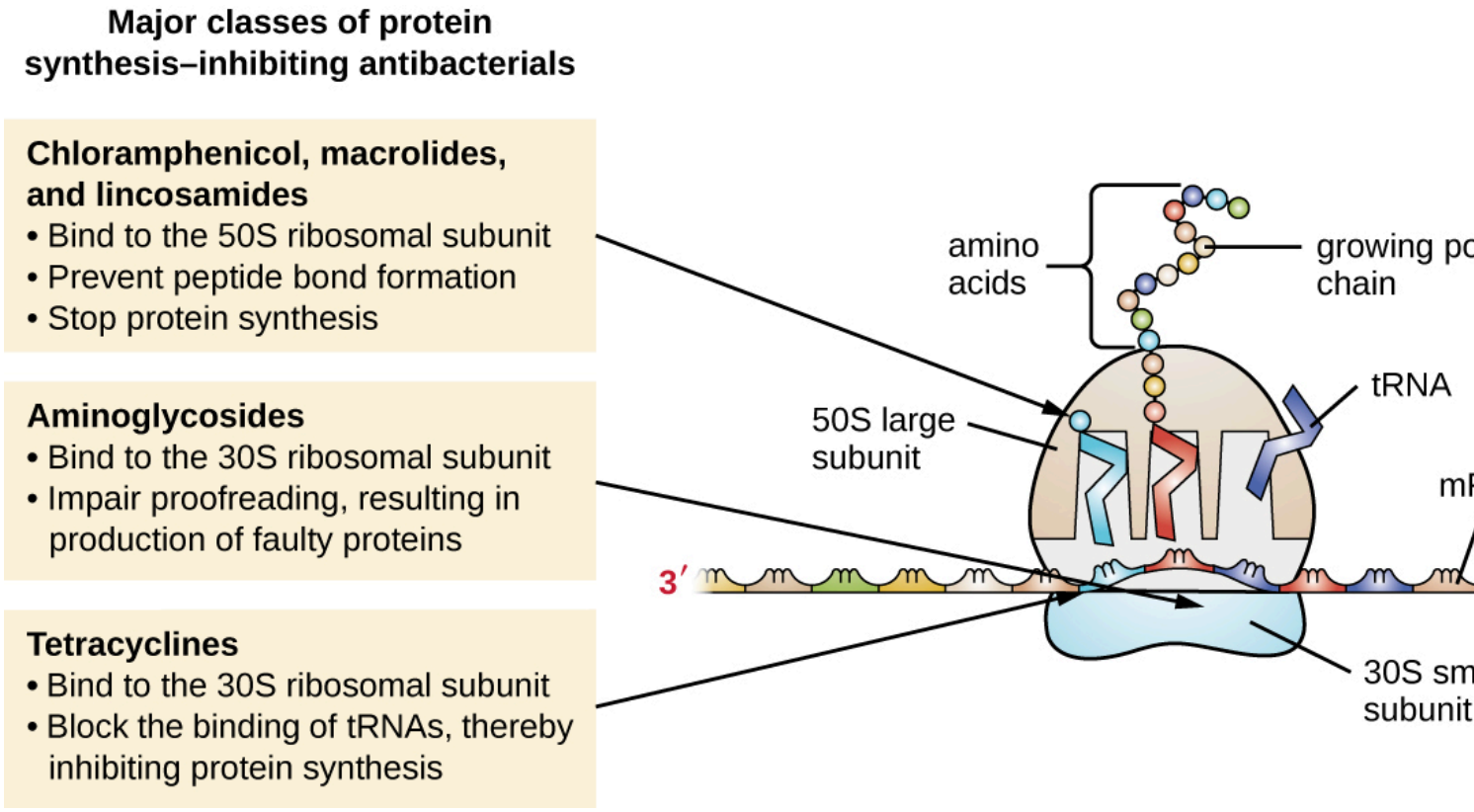


Figure 3.9 Medications that inhibit protein synthesis

Special Administration Considerations: Aminoglycosides can result in many adverse effects for the patient and, therefore, the nurse should monitor the patient carefully for signs of emerging concerns. Peak and trough levels are used to titrate this medication to a safe dose. Aminoglycosides can be nephrotoxic (damaging to kidney), neurotoxic (damaging to the nervous system), and ototoxic (damaging to the ear). Nurses should monitor the patient receiving aminoglycosides for signs of decreased renal function such as declining urine output and increasing blood urea nitrogen (BUN), creatinine, and declining glomerular filtration rate (GFR). Indications of damage to the neurological system may be assessed as increasing peripheral numbness or tingling in the extremities. Additionally, the patient should be carefully assessed for hearing loss or hearing changes throughout the course of drug administration.

Patient Teaching & Education: Patients receiving aminoglycosides should be advised to monitor for signs of hypersensitivity and auditory changes. This may include tinnitus and hearing loss. Patients may also experience accompanying vertigo while on the medication. Patients should be advised to drink plenty of fluids while taking the medication. Female patients should notify their provider if pregnancy

is planned or if they are actively breastfeeding.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for streptomycin and gentamycin in Table 3.12.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.12 Streptomycin and Gentamycin Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Aminoglycosides	streptomycin gentamicin	Check for allergies Obtain culture before administering IM: Blood sample for peak level should be obtained 1 to 2 hours after IM injection; obtain blood for trough level just before next dose Inject in a large muscle Handle carefully; use gloves to prepare Monitor peak and trough levels	Monitor for systemic signs of infection: – WBCs – Fever Monitor actual site of infection Monitor culture results	GI upset Rash Report diarrhea immediately SAFETY: Nephrotoxicity: monitor renal function closely Risk for severe neurotoxic reactions, especially with renal impairment. Can result in respiratory paralysis if given soon after anesthesia or muscle relaxant Risk for ototoxicity, especially if administered with a loop diuretic Can cause harm to fetus and breastfed infants

Critical Thinking Activity 3.12a

Using the above grid information, consider the following clinical scenario question:

A patient is admitted with streptococcal endocarditis and the nurse is preparing the morning dose of streptomycin. The lab has not yet arrived to obtain the trough level, and the drug is now overdue to be given. What is the nurse's next best response?

Note: Answers to the Critical Thinking activities can be found in the “Answer Key” sections at the end of the book.

3.13 Tetracyclines

Open Resources for Nursing (Open RN)

Tetracyclines are broad-spectrum antibiotics that are bacteriostatic, subsequently inhibiting bacterial growth.

Indications: Tetracycline medications are useful for the treatment of many gram-positive and gram-negative infectious processes, yet are limited due to the significance of side effects experienced by many patients.

Mechanism of Action: Tetracyclines work by penetrating the bacterial cell wall and binding to the 30S ribosome, inhibiting the protein synthesis required to make the cellular wall.

Special Administration Considerations: Significant side effects of tetracycline drug therapy include photosensitivity, discoloration of developing teeth and enamel hypoplasia, and renal and liver impairment.

Tetracyclines are contraindicated in pregnancy and for children ages 8 and under. Small amounts may be excreted in breast milk.

Patient Teaching & Education: Patients should be instructed to avoid direct sunlight exposure and wear sunscreen to prevent skin sensitivities. Additionally, it is important for patients to be educated regarding potential impaired absorption of tetracycline with the use of dairy products. Patients who are on oral contraceptives should be educated that tetracyclines may impede the effectiveness of the oral contraceptive and an alternative measure of birth control should be utilized while on the antibiotic. Female patients must be aware to immediately stop tetracycline if they become pregnant. Expired tetracycline should be immediately disposed of as it can become toxic.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let’s take a closer look at the medication grid for tetracycline in Table 3.13.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.13 Tetracycline Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Tetracyclines	tetracycline	Check allergies	Monitor for systemic	Gastrointestinal symptoms

Alert: Check expiration date. Using outdated or deteriorated drug has been linked to severe reversible nephrotoxicity (Fanconi syndrome)		
Effectiveness is reduced when drug is given with milk or other dairy products, antacids, or iron products		C-diff
		Photosensitivity
For best drug absorption, give drug with a full glass of water on an empty stomach at least 1 hour before or 2 hours after meals	signs of infection:	Oral candidiasis
	-WBCs	Permanent teeth discoloration if given to patients < 8 y.o.
Give drug at least 1 hour before bedtime to prevent esophageal irritation or ulceration	– Fever	
	Monitor actual site of infection	Intracranial hypertension: Monitor for headache, blurred vision, diplopia, and vision loss
Use caution with renal or hepatic impairment		
		Decreased effectiveness of oral contraceptives
Avoid using in children younger than age 8 because drug may cause permanent discoloration of teeth, enamel defects, and bone growth retardation		
Avoid in pregnancy due to toxic effects on the developing fetus (often related to retardation of skeletal development and teeth)		

Critical Thinking Activity 3.13a

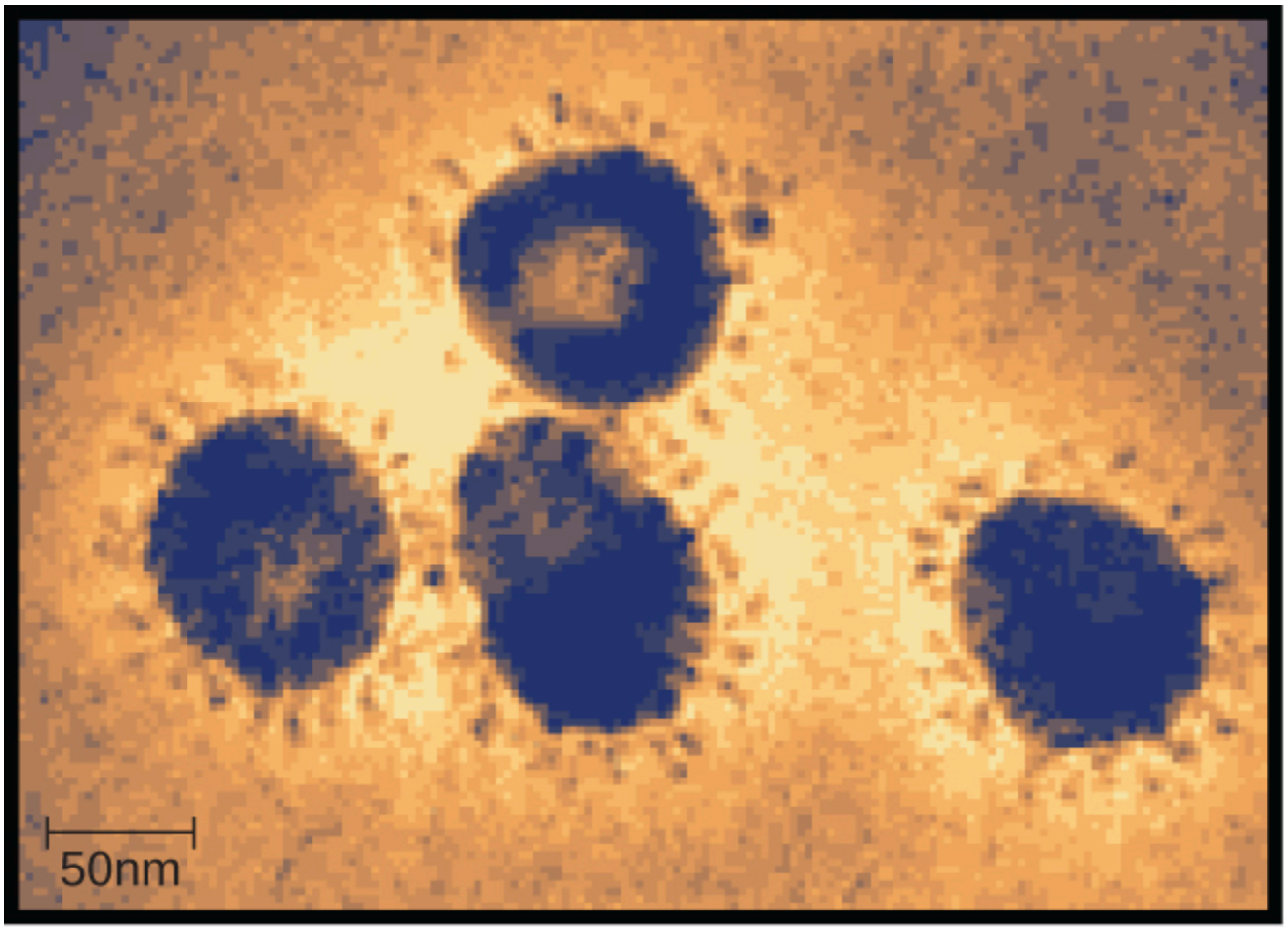
Using the above grid information, consider the following clinical scenario question:

The nurse is providing medication teaching to a parent of a six-year-old child with strep throat in a clinic setting. Due to multiple drug allergies, tetracycline was prescribed by a doctor who is new to the clinic. What is the nurse's best response and why?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.14 Antivirals

Open Resources for Nursing (Open RN)



(a)

Figure 3.10 Images of viruses (a) Members of the Coronavirus family can cause respiratory infections like the comm
respiratory syndrome (MERS). Here they are viewed under a transmission electron microscope (TEM). (b) Ebolavir
by Centers for Disease Control and Prevention; credit b: modification of work by Thomas W. Geisbert)

Unlike the complex structure of fungi or protozoa, viral structure is simple. There are several subclasses of antiviral medications: antiherpes, antiinfluenza, anti-hepatitis, and antiretrovirals. Each subclass will be discussed in more detail below. See Figure 3.10
"Unknown" by CNX OpenStax is licensed under CC BY 4.0 Access for free at https://openstax.org/books/microbiology/pages/1-3-types-of-microorganisms
for images of viruses.

Subclass: Antiherpes

Indications: Acyclovir (Zovirax) and its derivatives are frequently used for the treatment of herpes and varicella virus infections, including genital herpes, chickenpox, shingles, Epstein-Barr virus infections,

and cytomegalovirus infections.

Mechanism of Action: Acyclovir causes termination of the DNA chain during the viral replication process. Acyclovir can be administered either topically or systemically, depending on the infection.

Special Administration Considerations: Acyclovir use may result in nephrotoxicity.

Patient Teaching & Education: Patients who are being treated with antiviral therapy should be instructed about the importance of medication compliance. They may also experience significant fatigue, so periods of rest should be encouraged.

Subclass: AntiInfluenza

Indications: Tamiflu (oseltamivir) is used to target the influenza virus by blocking the release of the virus from the infected cells.

Mechanism of Action: Tamiflu prevents the release of virus from infected cells.

Special Administration Considerations: This medication does not cure influenza, but can decrease flu symptoms and shorten the duration of illness if taken in a timely manner. Patients are prescribed the medication for prophylaxis against infection, known exposure, or to lesson the course of the illness. If patients experience flu-like symptoms, it is critical that they start treatment within 48 hours of symptom onset.

Patient Teaching & Education: Patients who are being treated with antiviral therapy should be instructed about the importance of medication compliance. They may also experience significant fatigue, so periods of rest should be encouraged.

The influenza virus is one of the few RNA viruses that replicates in the nucleus of cells. Antivirals block the release stage. See Figure 3.11.

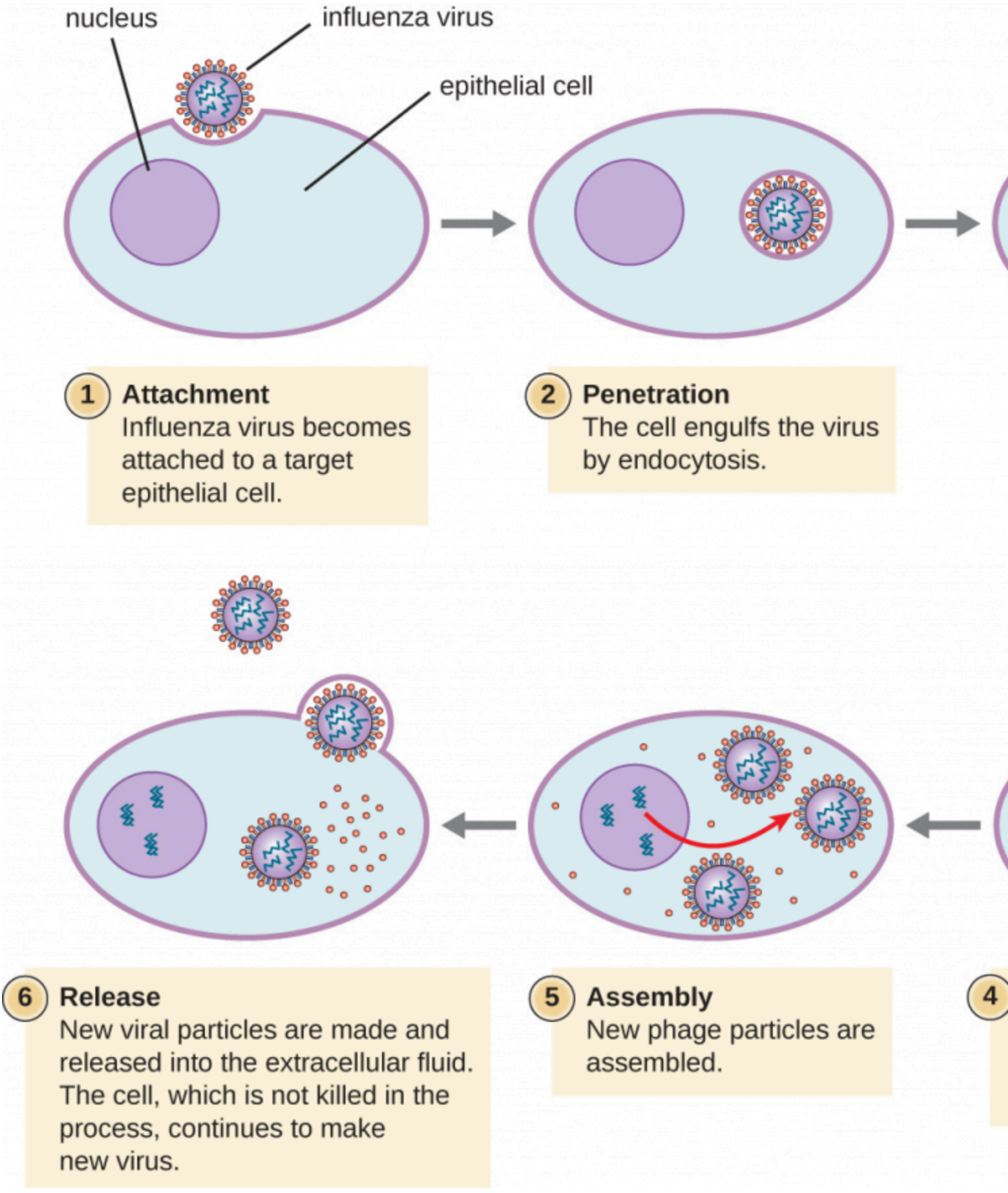


Figure 3.11 Influenza virus replication stages

Subclass: Antiretrovirals

Viruses with complex life cycles, such as HIV, can be more difficult to treat. These types of viruses require the use of antiretroviral medications that block viral replication. (See Figure 3.12 to view the viral replication process of HIV.)

Additionally, antiretrovirals fall under the class of antiviral medications.

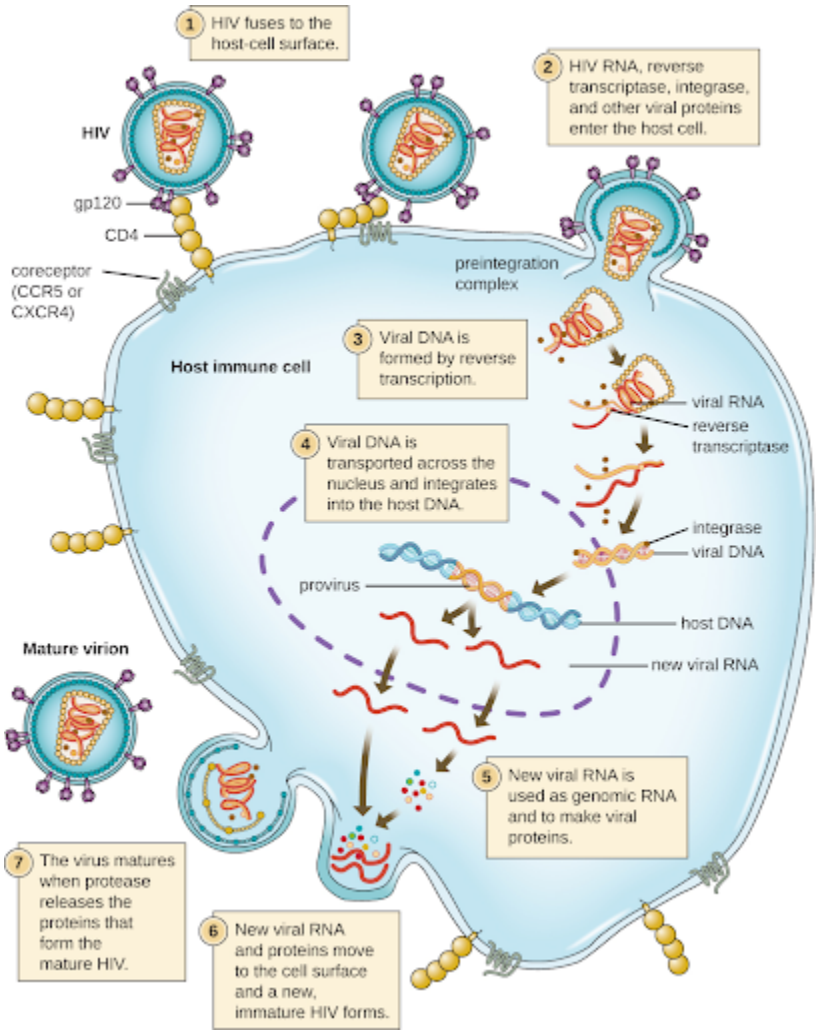


Figure 3.12 HIV attaches to a cell surface receptor of an immune cell and fuses with the cell membrane. Viral contents are released into the cell, where viral enzymes convert the single-stranded RNA genome into DNA and incorporate it into the host genome

Indications: Antiretrovirals are used for the treatment of illnesses like HIV.

Mechanism of Action: Antiretrovirals impede virus replication.

Special Administration Considerations: Many antiretrovirals may impact renal function; therefore, the patient's urine output and renal labs should be monitored carefully for signs of decreased function.

Patient Teaching & Education: Patients who are being treated with antiviral therapy should be instructed about the importance of antiretroviral compliance. They may also experience significant fatigue, so periods of rest should be encouraged.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grids for the subclasses of antivirals in Table 3.14a-d.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Tables 3.14a Acyclovir Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antivirals: Antiherpes	acyclovir	Check for allergies Route: PO, IV, or topical; do not give IM or subcutaneously (subq) Give with food if GI distress IV: Give IV infusion over at least 1 hour to prevent renal tubular damage Use cautiously if renal impairment, neurological problems, or dehydration Start therapy as early as possible after signs or symptoms occur Encourage fluid intake Avoid sexual contact while lesions present	Drug is not a cure for herpes but improves signs and symptoms of herpes lesions if started early Can be used long term for prevention of outbreaks	GI distress Monitor renal function in long-term use, especially if renal impairment Lowers seizure threshold

Tables 3.14b Oseltamivir Medication Grid

Class/ Subclass	Prototype/	Administration Considerations	Therapeutic Effects	Side/Adverse Effects

	Generic			
				GI distress Serious skin/ hypersensitivity reactions; discontinue immediately Monitor for neuropsychiatric symptoms Use cautiously in patients with renal failure, chronic cardiac or respiratory diseases, or any medical condition that may require imminent hospitalization
Antivirals: **AntiInfluenza Agents**	oseltamivir	Check for allergies Route: PO Must be given within 48 hours of onset of symptoms Administer with food to avoid GI distress Does not replace need for annual influenza vaccination	Reduce duration of flu symptoms	

Tables 3.14c Adefovir Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antivirals: **Anti-Hepatitis Agents**	adefovir	Route: PO Prolonged therapy (>1 year or indefinitely) based on patient status Offer HIV testing; may promote resistance to antiretrovirals in patients with chronic HBV infection who also have unrecognized or untreated HIV infection Do not stop taking medication unless	Maintain or improve liver function when active disease is present	Severe acute exacerbations of Hepatitis B Nephrotoxicity Lactic acidosis Severe hepatomegally

		directed. Monitor hepatic function several months after stopping therapy		

Tables 3.14d Lamuvadine-Zidovudine Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antivirals: **Antiretrovirals** **Nucleoside–** **nucleotide reverse transcriptase inhibitors**	lamivudine-zidovudine	Check for allergies Lamivudine used to treat HIV-1 infection contains a higher dose of the active ingredient than the lamivudine used to treat chronic HBV infection. Patients with HIV-1 infection should receive only dosing forms appropriate for HIV-1 treatment Use cautiously in patients with renal impairment Inform patient that drug doesn't cure HIV infection, that opportunistic infections and other complications of HIV infection may still occur, and that transmission of HIV to others through sexual contact or blood contamination is still possible. Taking these medications, along with practicing safer sex and making other lifestyle changes, may decrease the risk of transmitting	Decreases chance of developing acquired immunodeficiency syndrome (AIDS) and HIV-related illnesses such as serious infections or cancer	Lactic acidosis Severe hepatomegaly Stop treatment immediately if pancreatititis

(spreading) the HIV or hepatitis B virus to other people

Teach symptoms of pancreatitis

Critical Thinking Activity 3.14a

Using the above grid information, consider the following clinical scenario question:

A patient is prescribed oseltamivir (Tamiflu) for influenza symptoms. The patient states to the nurse, "I hope this medication works quickly! I have felt lousy for the past 5 days!" What is the nurse's next best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.15 Antifungals

Open Resources for Nursing (Open RN)

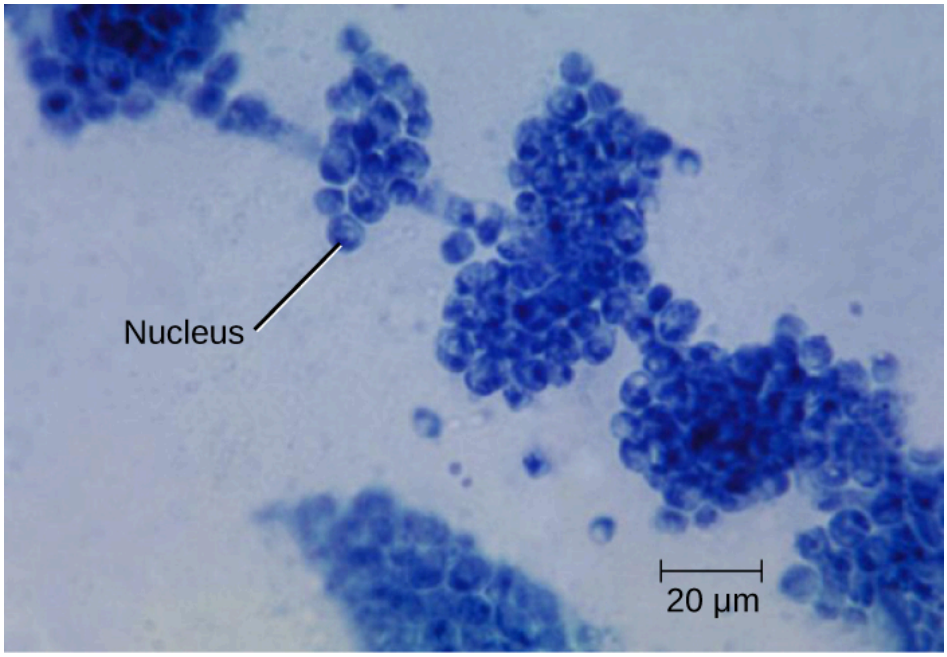


Figure 3.13 Candida albicans is a unicellular fungus, or yeast. It is the causative agent of vaginal yeast infections as well as oral thrush, a yeast infection of the mouth that commonly afflicts infants.

This image is a derivative of "Candida albicans" by Dr. Gordon Roberstad, Centers of Disease Control and Prevention.

https://cnx.org/contents/y54zcuVm@1/Characteristics-of-Fungi, licensed under CC0

Fungi are important to humans in a variety of ways. Both microscopic and macroscopic fungi have medical relevance, but some pathogenic species that can cause **mycoses** (illnesses caused by fungi). See Figure 3.13 for a microscopic image of candida albicans that is the causative agent of yeast infections. Some pathogenic fungi are opportunistic, meaning that they mainly cause infections when the host's immune defenses are compromised and do not normally cause illness in healthy individuals. Fungi are important in other ways. They act as decomposers in the environment, and they are critical for the production of certain foods such as cheeses. Fungi are also major sources of antibiotics, such as penicillin from the fungus *Penicillium*.

.

Indications:

Imidazoles are synthetic fungicides commonly used in medical applications and also in agriculture to keep seeds and harvested crops from molding. Examples include miconazole, ketoconazole, and clotrimazole, which are used to treat fungal skin infections such as ringworm, specifically tinea pedis (athlete's foot), tinea cruris (jock itch), and tinea corporis.

Triazole drugs, including fluconazole, can be administered orally or intravenously for the treatment of several types of systemic yeast infections, including oral thrush and cryptococcal meningitis, both of which are prevalent in patients with AIDS. Triazoles also exhibit more selective toxicity, compared with the imidazoles, and are associated with fewer side effects.

Allylamines, a structurally different class of synthetic antifungal drugs, are most commonly used topically for the treatment of dermatophytic skin infections like athlete's foot, ringworm, and jock itch. Oral treatment with terbinafine is also used for fingernail and toenail fungus, but it can be associated with the rare side effect of hepatotoxicity.

Polyenes are a class of antifungal agents naturally produced by certain actinomycete soil bacteria and are structurally related to macrolides. Common examples include nystatin and amphotericin B. Nystatin is typically used as a topical treatment for yeast infections of the skin, mouth, and vagina, but may also be used for intestinal fungal infections. The drug amphotericin B is used for systemic fungal infections like aspergillosis, cryptococcal meningitis, histoplasmosis, blastomycosis, and candidiasis. Amphotericin B was the only antifungal drug available for several decades, but its use has associated serious side effects, including nephrotoxicity.

Mechanism of Action: Antifungals disrupt ergosterol biosyntheses of the cell membrane increasing cellular permeability and causing cell death.

Special Administration Considerations: Administration guidelines will vary depending on the type of fungal infection being treated. It is important to monitor response of the affected area and examine class

specific administration considerations to monitor patient response.

Patient Teaching & Education: The patient should be advised to follow dosage instructions carefully and finish the drug completely, even if they feel their symptoms have resolved. The patient should report any skin rash, abdominal pain, fever, or diarrhea to the provider. The patient should monitor carefully for unexplained bruising or bleeding, which may be a sign of liver dysfunction.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for various antifungals in Table 3.15.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.15 Antifungal Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antifungals	clotrimazole	Check for allergies Topical cream: apply liberally twice daily to affected area	Improve symptoms of athlete's foot (tinea pedis), jock itch (tinea cruris), or ringworm	Topical-skin irritation, rash
	fluconazole	Check for allergies Route: PO/IV Single or multiple doses Caution if liver dysfunction Potential for fetal harm	Improve symptoms of yeast infection	Hepatotoxicity
	terbinafine	Cream or aerosol Wash affected area with soap and water and allow to dry completely before applying	Improve symptoms of athlete's foot (tinea pedis), jock itch (tinea cruris), or ringworm	External use only
	nystatin	PO: If order is "'swish and swallow," instruct patient to hold medication in mouth for several minutes before swallowing Topical cream/powder:	Improve symptoms of yeast infection of skin	External use only

	apply liberally twice daily Check for allergies Route: IV Reconstitute and dilute as directed on packaging Administer slowly over several hours initially and monitor VS every 30 minutes; may require premedication Therapy may take several months Alert: Different amphotericin B preparations aren't interchangeable Caution if renal impairment Black Box Warning: Don't use to treat noninvasive forms of fungal disease in patients with normal neutrophil counts		Monitor fluid intake and output; report change in urine appearance or volume Monitor BUN and creatinine levels two or three times weekly. Kidney damage may be reversible if drug is stopped at first sign of renal dysfunction Hydrate patient before infusion to reduce risk of nephrotoxicity Obtain liver function tests once or twice weekly Monitor CBC weekly Monitor potassium level closely and report signs of hypokalemia Check calcium and magnesium levels twice weekly Drug may be ototoxic. Report evidence of hearing loss, tinnitus, vertigo, or unsteady gait
amphotericin B		Improvement of systemic fungal infection such as aspergillis	

Critical Thinking Activity 3.15a

Using the above grid information, consider the following clinical scenario question:

A patient in a skilled nursing facility has been receiving nystatin applied to groin folds twice daily for several weeks, but there is no sign of improvement. What is the nurse's best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.16 Antimalarials

Open Resources for Nursing (Open RN)

Malaria is a prevalent protozoal disease impacting individuals across the world. According to the Centers for Disease Control, approximately 1,700 cases of malaria are diagnosed in the United States each year.
Centers for Disease Control and Prevention. (2018, November 15). *Choosing a drug to prevent malaria.* https://www.cdc.gov/malaria/travelers/drugs.html

Indications: Antimalarials are used for the prevention or treatment of malaria.

Mechanism of Action: Antimalarial agents work by targeting specific intracellular processes that impact cell development.
Achieng, A., Rawat, M., Ogutu, B., Guyah, B., Ong'echa, J.M., Perkins, D., & Kempaiah, P. (2017). Antimalarials: Molecular drug targets and mechanism of action. *Current Topics in Medicinal Chemistry, 17*, 1-15.

Special Administration Considerations: Antimalarial medications may impact hearing and vision so patients should be monitored carefully for adverse effects. Additionally, antimalarial medications may cause GI upset, so patients should be instructed to take these medications with food.

Patient Teaching & Education: Patients should receive instruction to take medication as prescribed and adhere to the full prescription regimen. Patients should minimize additional exposure to mosquitoes using preventative means such as repellents, protective clothing, netting, etc. Patients on chloroquine therapy should also avoid alcohol. Chloroquine can be extremely toxic to children and should be safely stored and out of reach. Patients receiving antimalarial therapy may have increased sensitivity to light and should be counseled to wear protective glasses to prevent ocular damage. Treatment often requires sustained regimens of six months or greater so patients should be monitored carefully for adherence and compliance.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on chloroquine in Table 3.16.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.16 Chloroquine Medication Grid

Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antimalarials	chloroquine	Check for allergies Contraindicated in patients hypersensitive to drug and in those with retinal or visual field changes	Prevention of malaria or improvement of an acute attack of malaria For malaria	Changes in vision Changes in hearing Monitor renal function closely Monitor patient for overdose,

Use cautiously in patients with severe GI, neurologic, or blood disorders; hepatic disease or alcoholism; or G6PD deficiency or psoriasis Take with food to prevent GI upset In severe or resistant cases, artesunate IV may be prescribed	prevention, the CDC recommends that patients take drug for 4 weeks after leaving the area	which can quickly lead to toxic symptoms: headache, drowsiness, visual disturbances, nausea and vomiting, cardiovascular collapse, shock, and convulsions

Critical Thinking Activity 3.16a

Using the above grid information, consider the following clinical scenario question:

A nurse is providing medication teaching to a patient who is planning on visiting a country with high rates of malaria to do mission work. The patient states, "I'm glad I only have to take this medication for a week. The side effects sound horrific!" What is the nurse's best response regarding the length of therapy?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.17 Antiprotozoals

Open Resources for Nursing (Open RN)

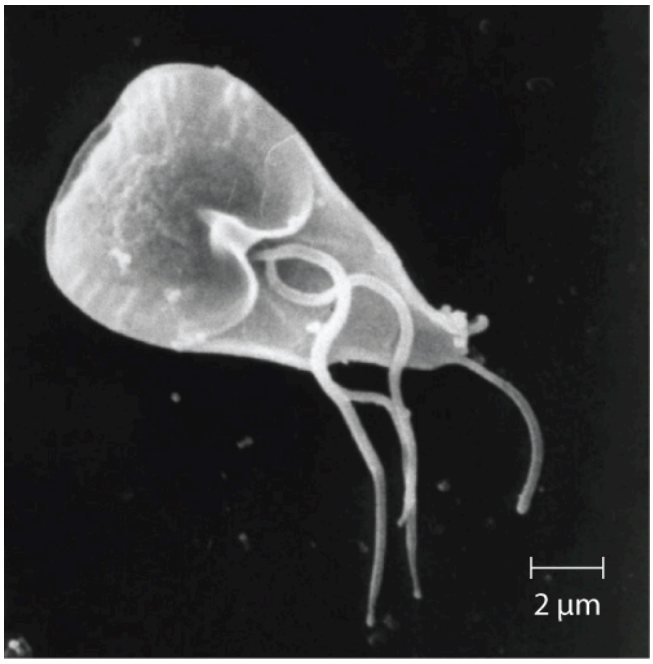


Figure 3.14 Giardia lamblia

Antiprotozoal drugs target infectious protozoans such as Giardia, an intestinal protozoan parasite that infects humans and other mammals, causing severe diarrhea (see Figure 3.14 for a microscopic image of Giardia).

Indications: Metronidazole is an example of an antiprotozoal antibacterial medication gel that is commonly used to treat acne rosacea, bacterial vaginosis, or trichomonas. Metronidazole IV is used to treat Giardia and also serious anaerobic bacterial infections such as Clostridium difficile (C-diff).

Mechanism of Action: Many antiprotozoal agents work to inhibit protozoan folic acid synthesis, subsequently impairing the protozoal cell.

Special Administration Considerations: It can be administered PO, parenterally, or topically. Orally is the preferred route for GI infections. The nurse should monitor the patient carefully for side effects such as seizures, peripheral neuropathies, and dizziness. Psychotic reactions have been reported with alcoholic patients taking disulfiram.

Patient Teaching & Education

Patients taking antiprotozoal medications should receive education regarding the need for medication compliance and prevention of reinfection. They should be advised that the medication may cause dizziness and dry mouth. Additionally, the medication may cause darkening of the urine. They should also avoid alcoholic beverages during medication therapy to prevent a disulfiram-like reaction.

If patients are being treated for protozoal infections such as trichomoniasis, they should be advised that sexual partners might be sources of reinfection even if asymptomatic. Partners should also receive treatment.

Patients teaching should include the avoidance of alcohol during therapy.

Now let's take a closer look at the medication grid in Table 3.17.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.17 Metronidazole Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antiprotozoal-antibacterial	metrogel metronidazole IV	Check for allergies Topical, vaginal, PO, or IV Don't give by IV push. Infuse over 30 to 60 minutes Contraindications: pregnancy, hypersensitivity, use of alcohol or disulfiram during therapy Use cautiously with hepatic impairment, blood dyscrasias or CNS diseases	Improvement of symptoms	Seizures Peripheral neuropathy Psychotic reactions Hepatotoxicity

Critical Thinking Activity 3.17a

Using the above grid information, consider the following clinical scenario question:

A patient develops C-diff after taking multiple antibiotics for a non-healing wound. What medication is commonly used to treat C-diff, and what route is used?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.18 Antihelmintic

Open Resources for Nursing (Open RN)

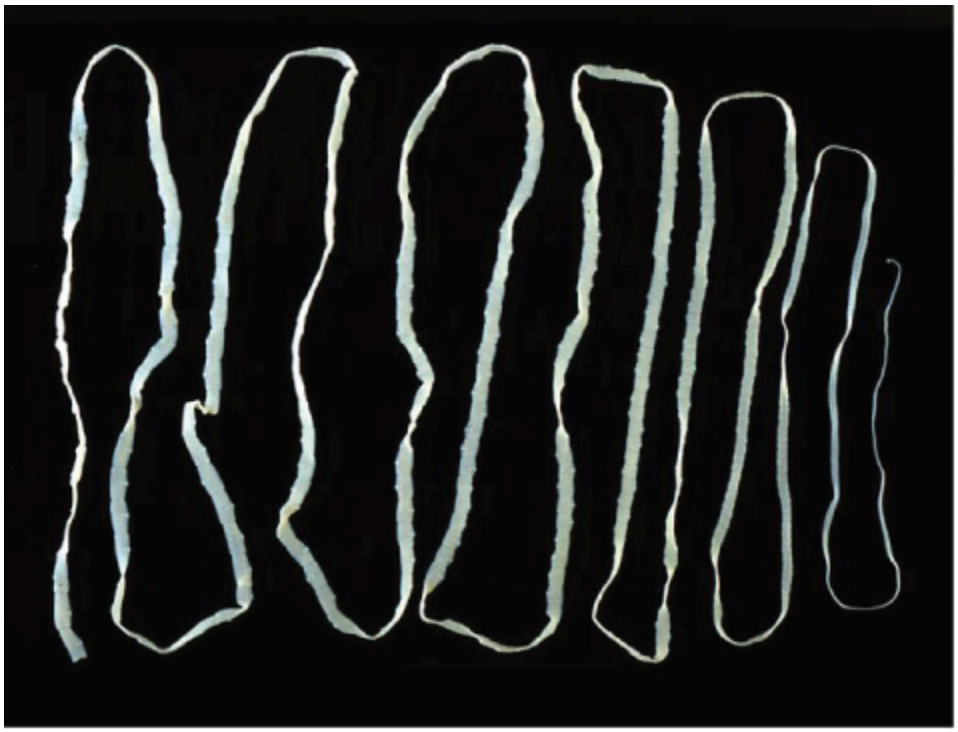
There are two major groups of parasitic helminths in the human body: the roundworms (Nematoda) and flatworms (Platyhelminthes). See Figure 3.15 for images of a tapeworm and a guinea worm.
This work is a derivative of "Taenia saginata adult 5260 lores.jpg" and "Dracunculus medinensis.jpg" by Centers for Disease Control and Prevention is licensed under CC0
Of the many species that exist in these groups, about half are parasitic and some are important human pathogens.

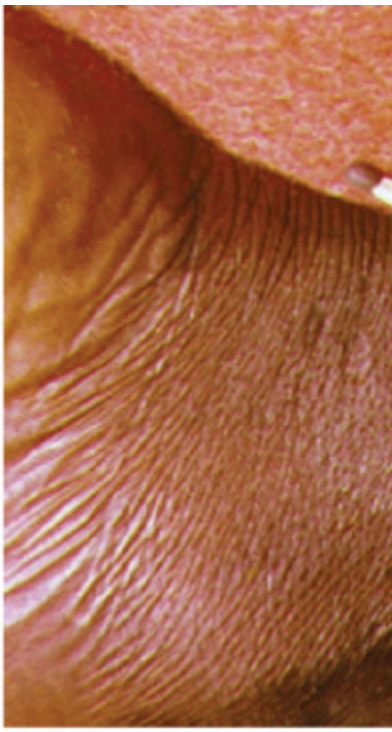
Indications: Anthelmintic medications target parasitic helminths.

Mechanism of Action: Because helminths are multicellular eukaryotes like humans, developing drugs with selective toxicity against them is extremely challenging. Despite this, several effective classes have been developed. Many anthelmintic medications work by preventing microtubule formation within the parasitic cell, compromising glucose uptake. Others work by blocking neuronal transmission within the parasite, subsequently causing starvation, paralysis, and death of the worms. Additionally, many antihelminths inhibit ATP formation and impair calcium uptake inducing paralysis and death.

Special Administration Considerations: Prolonged therapy using antihelmintic medication can result in liver damage and bone marrow suppression.

Patient Teaching & Education: Patients on antihelmintic drug therapy should receive special instruction to ensure rigorous hygienic precautions to minimize the risk of reinfection. They should also wash all bedding, linens, towels, and clothing following treatment to minimize reinfection risk.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral





(a)

Figure 3.15 A. The tapeworm Taenia saginata, that infects both cattle and humans. Eggs are microscopic, but the ad
meters, taking up residence in the digestive system B. An adult guinea worm, Dracunculus medinensis, is removed t
around a matchstick

Now let's take a closer look at the medication grid on mebendazole in Table 3.18.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.18 Mebendazole Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/ Adverse Effects
Antihelmintic	mebendazole	Contraindicated during pregnancy; may cause fetal harm To help prevent reinfection: -Wash hands and fingernails with soap often during the day, especially before eating and after using the toilet -Wash all fruits and vegetables thoroughly or cook them well -Wear shoes	Elimination of worms	In prolonged treatment: -Hepatic effects -Bone marrow suppression

Critical Thinking Activity 3.18a

Using the above grid information, consider the following clinical scenario question:

A mother reports that her four-year-old son had a worm in his stool this morning. They live on a dairy farm. She reports that her son enjoys being in the barn during chore time, and it is common for the livestock to develop "worms." Mebendazole was prescribed. What patient teaching should the nurse provide to the child and the mother?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.19 Antituberculars

Open Resources for Nursing (Open RN)

M. tuberculosis is the causative agent of tuberculosis (TB), a disease that primarily impacts the lungs but can infect other parts of the body as well. It has been estimated that one third of the world's population has been infected with M. tuberculosis and millions of new infections occur each year. Treatment of M. tuberculosis is challenging and requires patients to take a combination of drugs for an extended time. Complicating treatment even further is the development and spread of multidrug-resistant strains of this pathogen.

Indications: Antitubercular medications are selective for mycobacteria work by inhibiting growth or selectively destroying mycobacteria.

Mechanism of Action: They work impacting the synthesis or transcription of mycobacteria RNA or inhibiting the synthesis of mycolic acids in the cellular wall. Mycobacteria can develop resistance to antitubercular medications; therefore, strict compliance to drug regimen must be emphasized.

Special Administration Considerations: Antitubicular medications require at least six months of treatment. Many antitubercular medications may impact liver function, and liver enzymes should be monitored carefully. Other side effects to medication administration include GI symptoms, peripheral neuropathy, and vision changes.

Patient Teaching/Education: Advise patients that medications must be taken as directed. It is important that patients understand the significance of continuing drug therapy even after symptoms have resolved to prevent the spread of disease. Drug therapy may be continued for six months to two years. If a patient notices any change in visual acuity or eye discomfort, it should be reported immediately to the healthcare provider.

Patients should also be advised to avoid alcohol during antitubercular therapy because of the increased risk of liver toxicity. Foods containing tyramine such as tuna and Swiss cheese should be avoided.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on isoniazid in Table 3.19.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019.

,

Allen, R.H. (2019). Combined estrogen-progestin oral contraceptives: Patient selection, counseling, and use. UpToDate. Retrieved on July 8, 2019 from https://www.uptodate.com/contents/combined-estrogen-progestin-oral-contraceptives-patient-selection-counseling-and-use?search=Combined%20estrogen-progestin%20oral%20contraceptives:&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1

Table 3.19 Isoniazid Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Antitubercular (also known as antimycobacterials)	isoniazid	Direct observed therapy (DOT) may be initiated to ensure compliance with long-term therapeutic regimen Multiple-drug resistant tuberculosis (i.e., resistance to at least isoniazid and rifampin) presents difficult treatment problems. Treatment must be individualized and based on	Negative sputum smears Prevention or elimination of TB symptoms: (productive cough, fever, night sweats)	GI upset Hepatotoxicity May decrease effectiveness of oral contraceptives

	susceptibility studies
	May decrease effectiveness of oral contraceptives. Patients should be counseled to use alternate form of oral contraception
	Vitamin B6 supplementation is necessary in some patients for prevention of peripheral neuropathy

Critical Thinking Activity 3.19a

Using the above grid information, consider the following clinical scenario question:

A patient has been prescribed isoniazid as part of a multi-drug regimen for resistant TB. Direct observed therapy (DOT) has been initiated. The patient asks the nurse, "What does 'direct observed therapy' mean?" What is the nurse's best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.20 Miscellaneous Antibacterials: Glycopeptides

Open Resources for Nursing (Open RN)

Vancomycin is a glycopeptide commonly used to treat MRSA.

Indications: Vancomycin is a popular glycopeptide that is active against gram-positive bacteria. Vancomycin is commonly used to treat serious or severe infections when other antibiotics are ineffective or contraindicated, including those caused by MRSA.

Mechanism of Action: Glycopeptides are a class of medications that inhibit bacterial cell wall synthesis.

Special Administration Considerations: It is poorly absorbed from the GI tract, so it must be given by IV to treat a systemic infection. Oral vancomycin, on the other hand, is used to treat antibiotic-associated clostridium difficile (C-diff). Vancomycin poses a significant risk to kidney function and hearing; therefore, patients' trough levels must be monitored carefully for effective IV dosing to avoid complications. Patients receiving IV vancomycin may also experience a complication known as "red man syndrome" in which they experience a flushing of the skin and a reddish rash on the upper body when the infusion is administered too rapidly.

Patient Teaching/Education: Patients should be counseled to take medications as directed for the full course of antibacterial therapy. They should monitor for side effects such as hypersensitivity, tinnitus, hearing loss, and vertigo. Patients should promptly follow-up with their healthcare provider if no improvement in symptoms is identified.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on vancomycin in Table 3.20.
Daily Med, https://dailymed.nlm.nih.gov/dailymed/index.cfm, used for hyperlinked medications in this module. Retrieved June 27, 2019

Table 3.20 Vancomycin Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Miscellaneous Antibacterials: Glycopeptides	vancomycin	Check for allergies Route: IV but PO for C-diff Obtain culture prior to administering first dose Dosage adjustment is required for renal impairment Monitor trough levels IV should be administered in a diluted solution over a period of 60 minutes or more to avoid rapid-infusion-related reactions	Monitor for systemic signs of infection: -WBCs -Fever Monitor actual site of infection for improvement Monitor and report trough levels for targeted dosing	Nephrotoxicity Ototoxicity C-diff can occur up to 2 months after therapy ends Red-man syndrome can occur if drug is infused too rapidly. Signs and symptoms include maculopapular rash on face, neck, trunk, and limbs and pruritus and hypotension caused by histamine release. Stop infusion and contact provider. Prepare to administer diphenhydramine 50mg IV or PO. Monitor BP closely; IV fluids and/or vasopressors may be required if hypotensive. Infusion may be restarted at a slower rate after rash and itching resolve

Critical Thinking Activity 3.20a

Using the above grid information, consider the following clinical scenario question:

A nurse is caring for a patient who was prescribed vancomycin IV for a MRSA infection. The dose of medication is due now, but a trough level is not yet available in the chart. What is the nurse's next best response?

Note: Answers to the Critical Thinking activities can be found in the "Answer Key" sections at the end of the book.

3.21 Module Learning Activities

Open Resources for Nursing (Open RN)

Now that you've learned all about antimicrobials, practice applying your knowledge with the following activities.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=334#h5p-7

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=334#h5p-44

III. Glossary

Open Resources for Nursing (Open RN)

Antagonistic Interactions: Concurrent administration of two drugs causes harmful effects such as a decrease of drug activity, decreased therapeutic levels due to increased metabolism and elimination, or increased potential for toxicity due to decreased metabolism and elimination. An example of an antagonistic interaction is taking antacids with antibiotics, causing decreased absorption of the antibiotic.

Antifungal: Medications that are used to treat fungal infections. For example, nystatin is used to treat

Candida Albicans, a fungal infection.

Antiviral: Medications used to treat viral infections. For example, Tamiflu is used to treat influenza.

Bactericidal: Antimicrobial drugs that kill their target bacteria.

Bacteriostatic: Antimicrobial drugs that cause bacteria to stop reproducing but may not ultimately kill the bacteria.

Black Box Warnings: The strongest warnings issued by the Federal Drug Administration (FDA) that signify the drug carries a significant risk of serious or life-threatening adverse effects.

Broad-Spectrum Antimicrobial: An antibiotic that targets a wide variety of bacterial pathogens, including both gram-positive and gram-negative species.

Clostridium Difficile (C-diff): Clostridium difficile causes pseudomembranous colitis, a superinfection that can be caused by broad spectrum antibiotic therapy.

Culture: A test performed on various body substances for the presence of bacteria or fungus.

Dose Dependent: A more significant response occurs in the body when the medication is administered in large doses to provide a large amount of medication to the site of infection for a short period of time.

Gram-Positive: Gram-positive bacteria are classified by the color they turn after a chemical called Gram stain is applied to them. Infections caused by Streptococcus and Staphylococcus bacteria are examples of gram-positive infections.

Gram-Negative: Gram-negative bacteria are classified by the color they turn after a chemical called Gram stain is applied to them. Escherichia Coli (also known as E. Coli) is an example of a gram-negative infection.

Gram Stain: A test used to quickly diagnose types of bacterial infection. Gram-positive and gram-negative bacteria stain differently because their cell walls are different. Identification of bacteria as gram positive or gram negative assists the healthcare provider in selecting an appropriate antibiotic to treat the infection.

Half-Life: The rate at which 50% of a drug is eliminated from the bloodstream.

Indications: The use of a drug for treating a particular condition or disease. The FDA determines if there is enough evidence for a labeled indication of a drug. Providers may also prescribe medications for off-label indications if there is reasonable scientific evidence that the drug is effective, but these uses have not been approved by the FDA.

Mechanism of Action: The way in which a drug affects microbes at the cellular level.

Methicillin-Resistant S. Aureus (MRSA): An infection caused by Methicillin-resistant Staphylococcus aureus that is difficult to treat because it exhibits resistance to nearly all available antibiotics.

Narrow-Spectrum Antimicrobial: An antibiotic that targets only specific subsets of bacterial pathogens.

Pathogen: An organism causing disease to its host.

Prototype: A common individual drug that represents a drug class or group of medications having similar chemical structures, mechanism of actions, and modes of action.

Resistance: A characteristic of bacteria when sensitivity analysis is performed demonstrating lack of effective treatment by a particular antibiotic.

Sensitivity Analysis: A test performed in addition to a culture to select an effective antibiotic to treat a microorganism.

Superinfection: A secondary infection in a patient having a preexisting infection. C-diff and yeast infections as a result of antibiotic therapy are examples of superinfections.

Synergistic Interaction: Concurrent drug administration producing a synergistic interaction that is better than the efficacy of either drug alone. An example of synergistic drug combinations is trimethoprim and sulfamethoxazole (Bactrim).

Time Dependent: Time dependency occurs when greater therapeutic effects are seen with lower blood levels over a longer period of time.

Vancomycin-Resistant S. Aureus (VRSA): An infection caused by Vancomycin-resistant Staphylococcus aureus that is difficult to treat because it exhibits resistance to nearly all available antibiotics.

IV

Autonomic Nervous System

4.1 Autonomic Nervous System Introduction

Open Resources for Nursing (Open RN)

Learning Objectives

- Identify the classifications and actions of autonomic nervous system drugs
- Give examples of when, how, and to whom autonomic nervous system drugs may be administered
- Identify the side effects and special considerations associated with autonomic nervous system drugs
- Include considerations and implications of using autonomic nervous system drugs across the lifespan
- Include evidence-based concepts when using the nursing process related to medications that

affect the autonomic nervous system
- Identify and interpret related laboratory tests

Have you ever wondered what causes your heart to beat or your lungs to breathe? These are examples of **involuntary responses** the brain controls without the need for conscious thought. The autonomic nervous system (ANS) works using a balance of the sympathetic and parasympathetic nervous systems that regulate the body's involuntary functions, including heart rate, respiratory rate, digestion, and sweating. Many medications are used to control various cardiovascular, respiratory, and gastrointestinal conditions by acting on ANS receptors. Beta blockers and anticholinergic medications are the most commonly prescribed medications in this category.

4.2 Autonomic Nervous System Basics

Open Resources for Nursing (Open RN)

This section will review key anatomy concepts in the autonomic nervous system (ANS) related to the mechanism of action of medications. For more detailed information regarding the concepts reviewed, use the links provided to review detailed autonomic nervous system content in the Open Stax Anatomy and Physiology book:
Content can be found at https://openstax.org/books/anatomy-and-physiology/pages/12-1-basic-structure-and-function-of-the-nervous-system

Review the basic structure and function of the nervous system

Review the anatomy of sensory perception.

Review the anatomy of motor responses.

Review the divisions of the autonomic nervous system.

Review autonomic reflexes and homeostasis.

Review information on a few drugs that affect the autonomic nervous system.

Components and Functions of the Nervous System

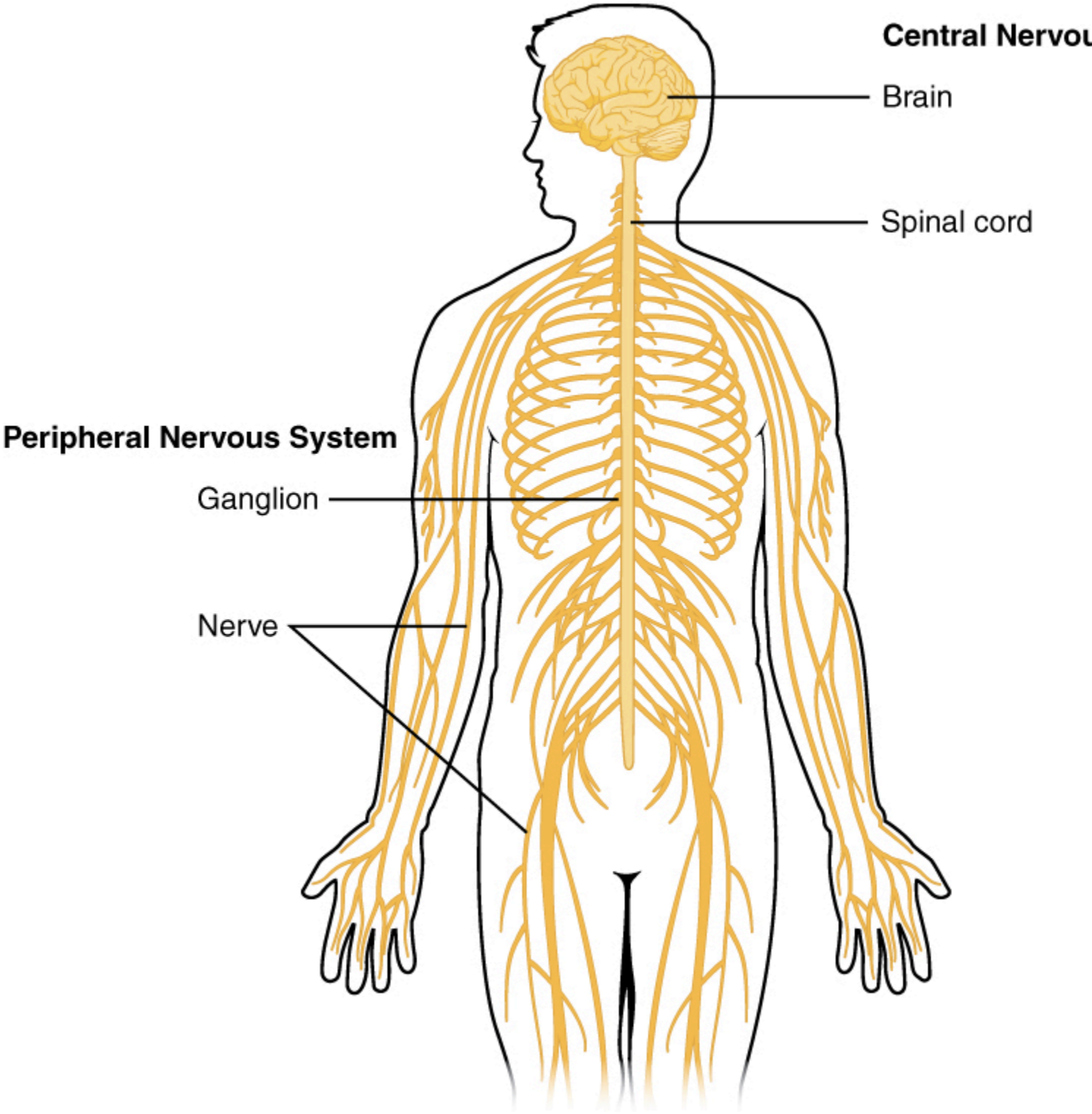


Figure 4.1 Central and Peripheral Nervous System

The nervous system has two major components: the central nervous system (CNS) and the peripheral nervous system. See Figure 4.1.

https://openstax.org/books/anatomy-and-physiology/pages/12-1-basic-structure-and-function-of-the-nervous-system
The **central nervous system (CNS)** is composed of the brain and the spinal cord. The**peripheral nervous system** includes nerves outside the brain and spinal cord and consists of sensory neurons and motor neurons. **Sensory neurons** sense the environment and conduct signals to the brain that become a conscious perception of that stimulus. This conscious perception may lead to a motor response that is conducted from the brain to the peripheral nervous system via motor neurons to cause a movement. **Motor neurons** consist of the **somatic nervous system** that stimulates voluntary movement of muscles and the **autonomic nervous system**

that controls involuntary responses. This chapter will focus on the autonomic nervous system.

The two divisions of the autonomic nervous system are the **sympathetic division (SNS)** and the **parasympathetic division (PNS)**. The SNS contains alpha and beta receptors, and the PNS contains nicotinic and muscarinic receptors. Each type of receptor has a specific action when stimulated. See Figure 4.2 for an image of the divisions of the nervous system and the receptors in the ANS.

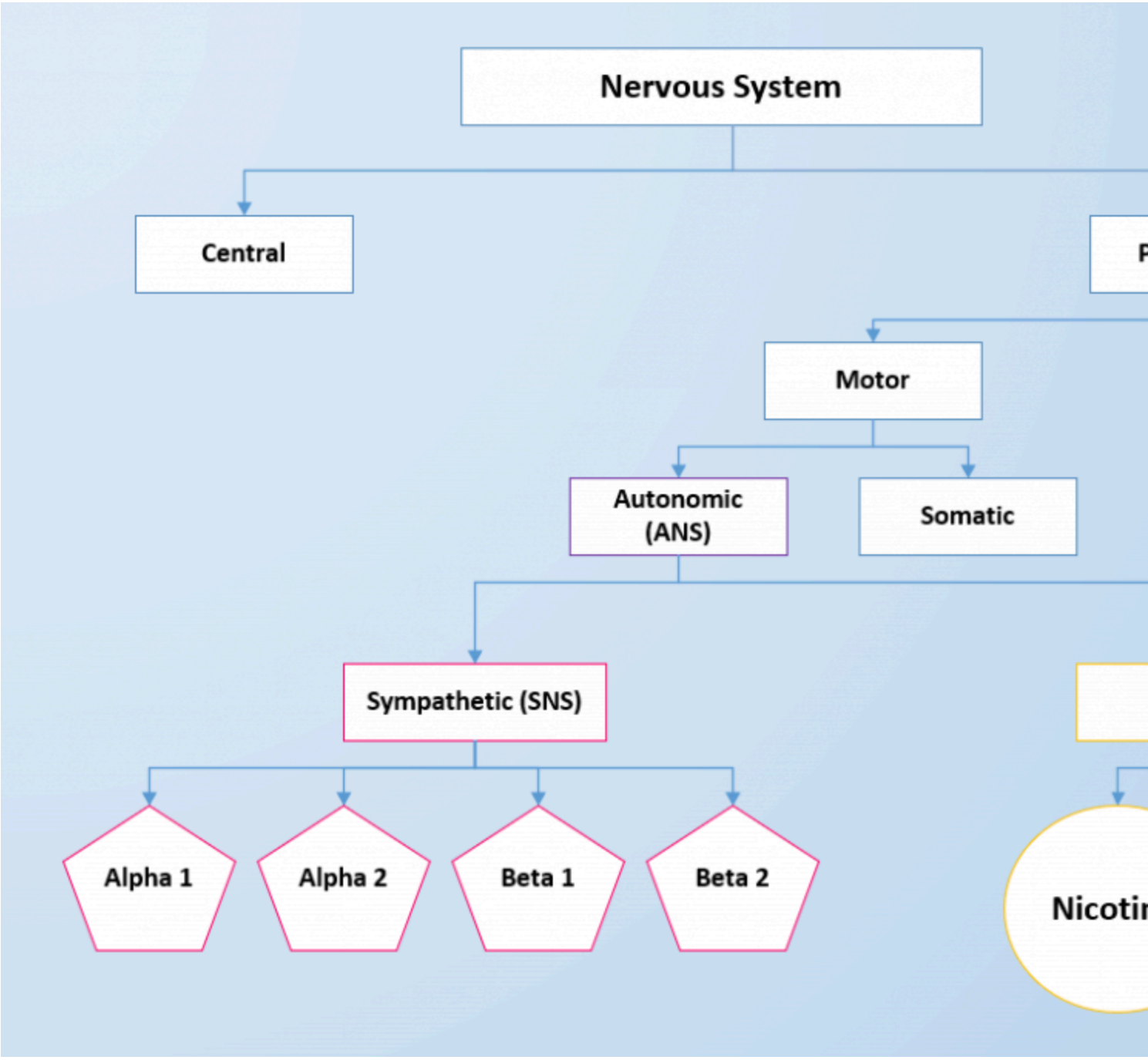


Figure 4.2 Components of the Nervous System and ANS receptors

SNS and PNS Functions and Homeostasis

The sympathetic system is associated with the **"fight-or-flight"** response, and parasympathetic activity is often referred to as "rest and digest." See Figure 4.3

to compare the effects on PNS and SNS stimulation on target organs. The autonomic nervous system regulates many of the internal organs through a balance of these two divisions and is instrumental in homeostatic mechanisms in the body.

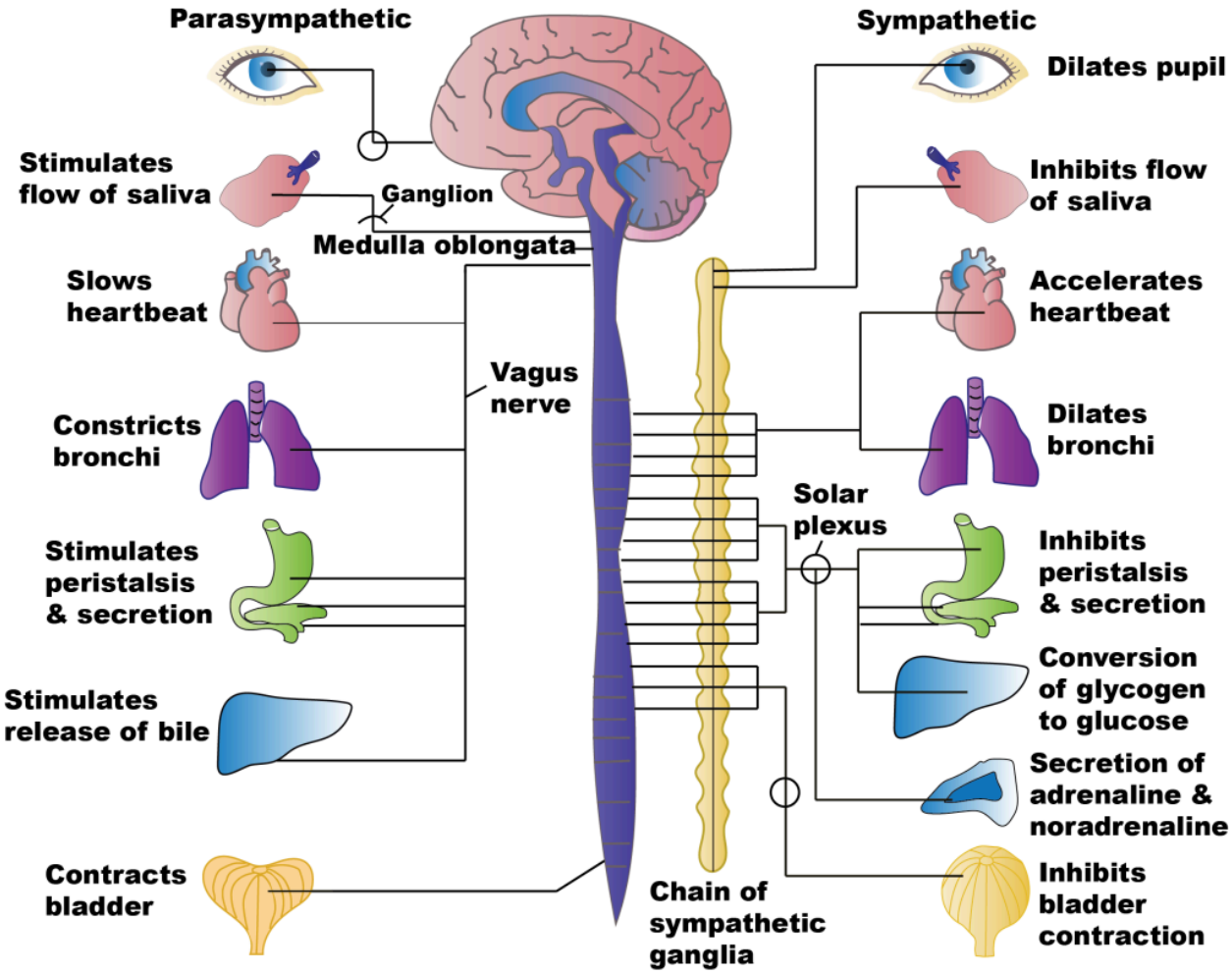


Figure 4.3. Effects of PNS and SNS Stimulation on Target Organs

Stimulation of SNS primarily produces increased heart rate, increased blood pressure via the constriction of blood vessels, and bronchial dilation. In comparison, stimulation of the PNS causes slowing of the heart, lowering of blood pressure due to vasodilation, bronchial constriction, and focuses on stimulating intestinal motility, salivation, and relaxation of the bladder.

Homeostasis is the balance between the two systems. At each target organ, dual innervation determines activity. For example, the heart receives connections from both the sympathetic and parasympathetic divisions. SNS stimulation causes the heart rate to increase, whereas PNS stimulation causes the heart rate to decrease.

To respond to a threat – to "fight or flight" – the sympathetic system stimulates many different target organs to achieve this purpose. For example, if a person sees a grizzly bear in the wilderness, the individual has the choice to stand and fight the bear or to run away. For either choice, several things must occur for additional oxygen and glucose to be delivered to skeletal muscle to fight or run. The respiratory, cardiovascular, and musculoskeletal systems are all activated to breathe rapidly, cause bronchodilation in the lungs to inhale more oxygen, stimulate the heart to pump more blood, and increase blood pressure to deliver it to the muscles.

The liver creates more glucose for energy for the muscles to use. The pupils dilate to see the threat (or the escape route) more clearly. Sweating prevents the body from overheating from excess muscle contraction. Since the digestive system is not needed during this time of threat, the body shunts oxygen-rich blood to the skeletal muscles. To coordinate all these targeted responses, catecholamines such as epinephrine and norepinephrine are released in the sympathetic system and disperse to the many neuroreceptors on the target organs simultaneously.

Chemical Signaling in the Autonomic Nervous System

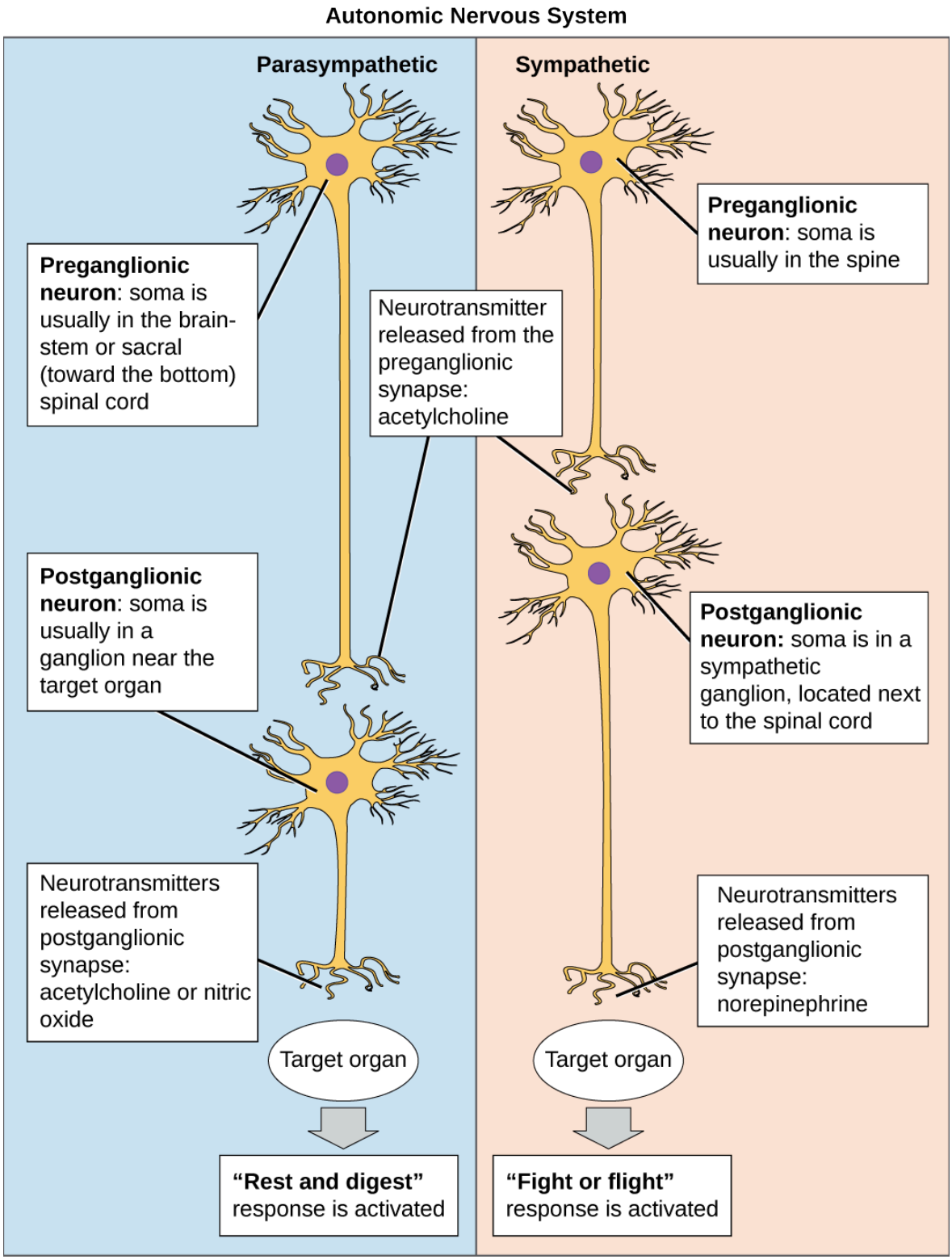


Figure 4.4 Autonomic System neurons conduct signals via the preganglionic neurons to postganglionic neurons to the target organs

Neurons conduct impulses to the synapse of a target organ. The **synapse** is a connection between the

neuron and its target cell. See Figures 4.4
"Autonomic Nervous System" by CNX OpenStax is licensed under CC BY 4.0
and 4.5
"The Synapse" by CNX OpenStax is licensed under CC BY 4.0 Access for free at https://openstax.org/books/anatomy-and-physiology/pages/12-5-communication-between-neurons
for images of synapse connections.

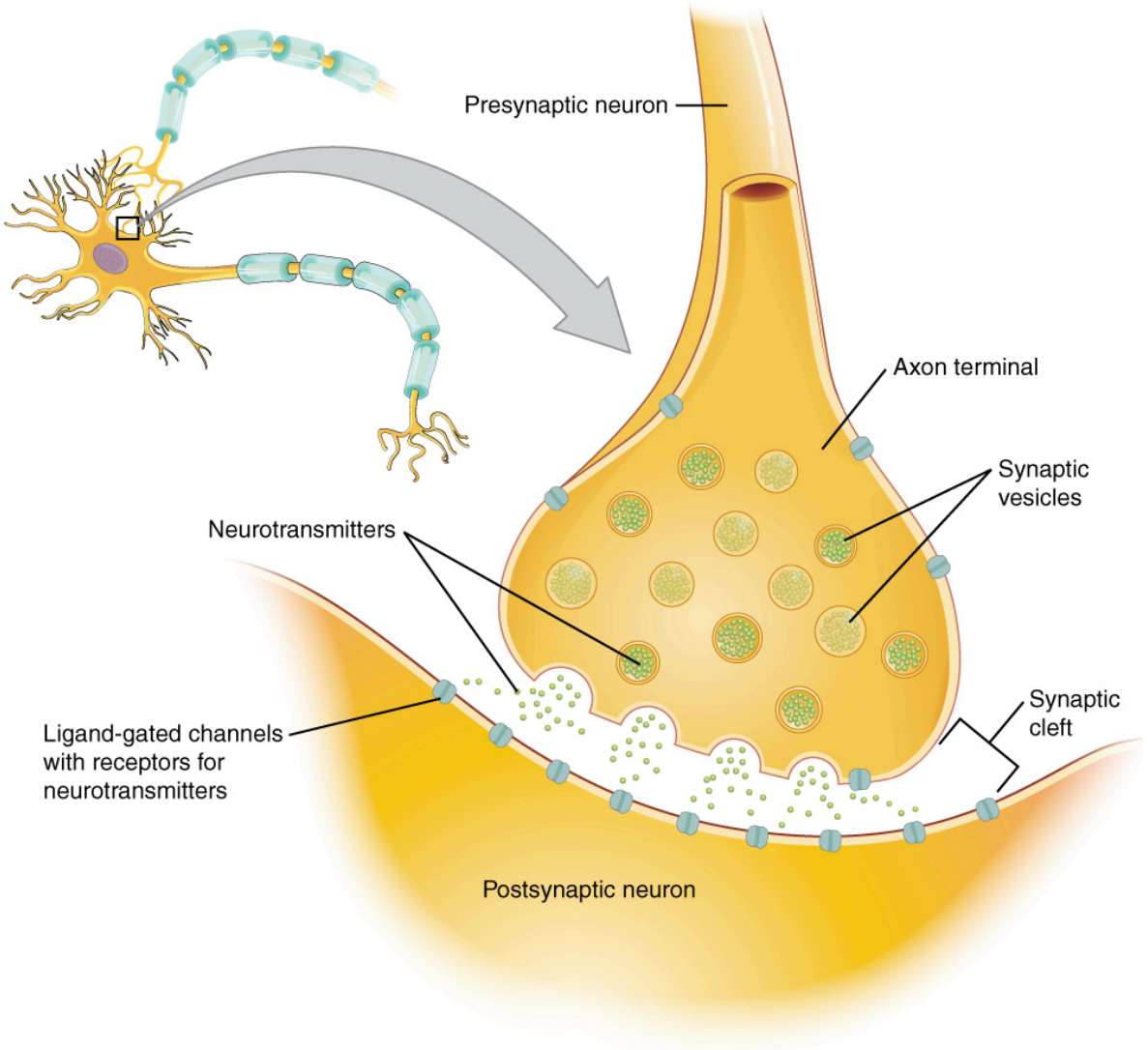


Figure 4.5 The synapse is the connection between a neuron and its target cell where neurotransmitters are released

Preganglionic Neurons

The synapse is composed of a preganglionic (presynaptic) neuron and a postganglionic (postsynaptic) neuron. **Preganglionic neurons** release **acetylcholine (ACh)** onto nicotinic receptors on the postganglionic neuron. Nicotine, found in tobacco products, also binds to and activates nicotinic receptors, mimicking the effects of ACh. This is worth noting, because if medications were developed to impact the nicotinic receptors, then it would impact both the SNS and PNS systems at the preganglionic level. Instead, most medications target the **postganglionic neurons**, because each type of postganglionic neuron has different neurotransmitters and different target receptors.

Postganglionic Neurons

There are different types of postganglionic neurons in the SNS and PNS branches of the autonomic nervous system. Postganglionic neurons of the PNS branch are classified as **cholinergic**, meaning that acetylcholine (ACh) is released, whereas postganglionic neurons of the SNS are classifed as **adrenergic**, meaning that norepinephrine (NE) is released. The terms cholinergic and adrenergic refer not only to the signal that is released, but also to the class of neuroreceptors that each binds. (See Figure 4.6 for an image of the release of ACh and NE and their attachment to the corresponding adrenergic or nicotinic receptors.)

The cholinergic system of the PNS includes two classes of postganglionic neuroreceptors: the nicotinic receptor and the muscarinic receptor. Both receptor types bind to ACh and cause changes in the target cell. The situation is similar to locks and keys. Imagine two locks—one for a classroom and the other for an office—opened by two separate keys. The classroom key will not open the office door, and the office key will not open the classroom door. This is similar to the specificity of nicotine and muscarine for their receptors. However, a master key can open multiple locks, such as a master key for the biology department that opens both the classroom and the office doors. This is similar to ACh that binds to both types of receptors.

The adrenergic system of the SNS has two major types of neuroreceptors: the alpha (α)-adrenergic receptor and beta (β)-adrenergic receptor. There are two types of α-adrenergic receptors, termed α1 and α2, and there are two types of β-adrenergic receptors, termed β1 and β2. An additional aspect of the adrenergic system is that there is a second neurotransmitter in addition to norepinephrine. The second neurotransmitter is called epinephrine. The chemical difference between norepinephrine and epinephrine is the addition of a methyl group (CH_3) in epinephrine. The prefix “nor-” actually refers to this chemical difference in which a methyl group is missing.

The term adrenergic should remind you of the word adrenaline, which is associated with the fight-or-flight response described earlier. Adrenaline and epinephrine are two names for the same molecule. The adrenal gland (in Latin, ad- = “on top of”; renal = “kidney”) secretes adrenaline. The ending “-ine” refers to the chemical being derived, or extracted, from the adrenal gland.

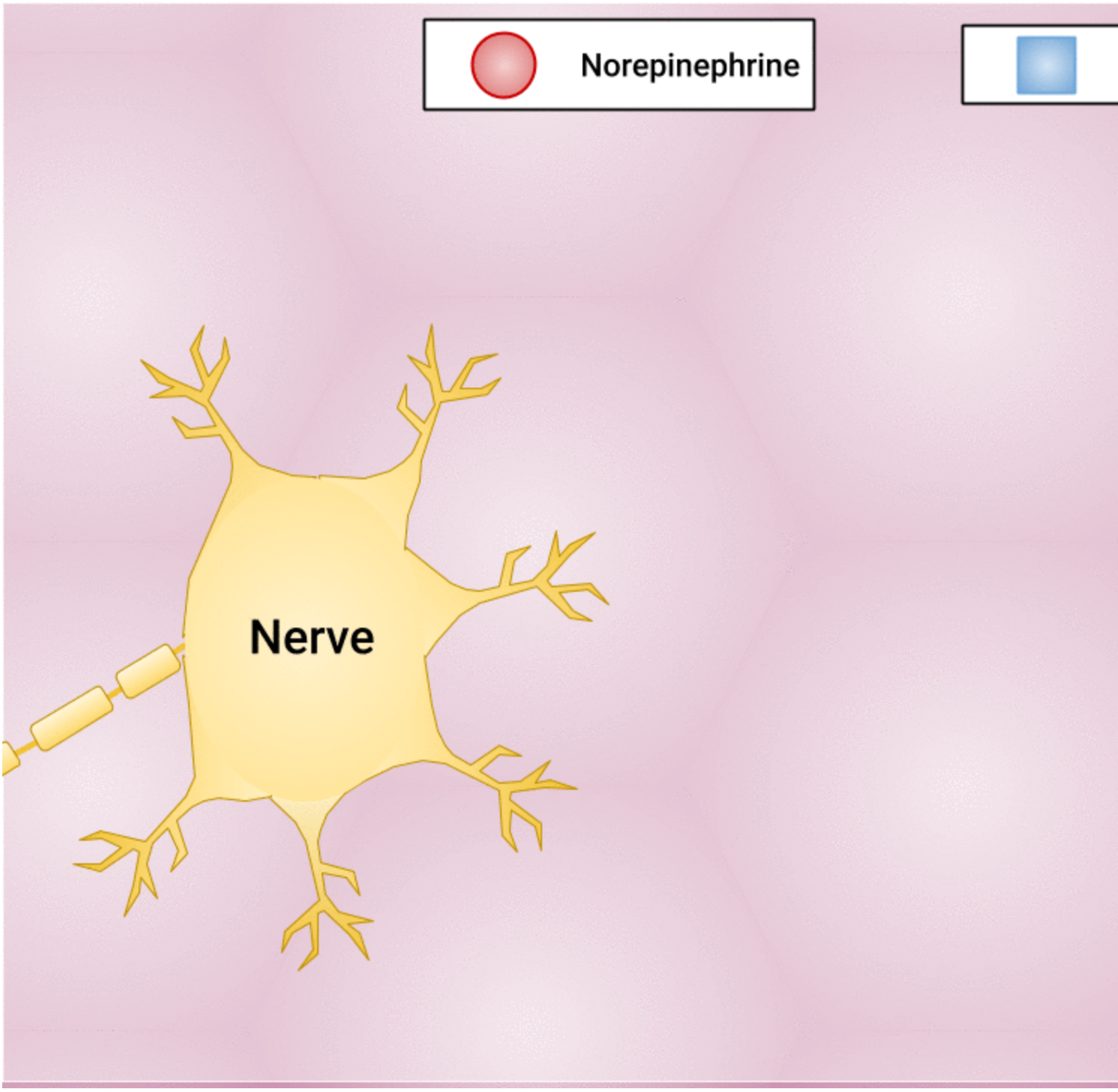


Figure 4.6 Sympathetic and Parasympathetic Pre-and Postganglionic Fibers and Neuroreceptors

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=822#h5p-8

ANS Neuroreceptors and Effects

The effects of stimulating each type of neuroreceptor are outlined in this section and sample uses of medications are provided.

Sympathetic Nervous System

SNS receptors include Alpha-1, Alpha-2, Beta-1, and Beta-2 receptors. Epinephrine and norepinephrine stimulate these receptors, causing the overall fight-or-flight response in various target organs. Medications causing similar effects are called **adrenergic agonists**, or **sympathomimetics**, because they mimic the effects of the body's natural SNS stimulation. On the other hand, **adrenergic antagonists** block the effects of the SNS receptors. Dopamine also stimulates these receptors, but it is dosage-based. Dopamine causes vasodilation of arteries in the kidney, heart, and brain, depending on the dosage. See Table 4.1 for a comparison of stimulation and inhibition of these SNS receptors.

Table 4.1 Comparison of Medication Effects of Adrenergic Receptor Stimulation and Inhibition

Receptor	Effects of Stimulation	Effects of Inhibition
Alpha-1	Contract smooth muscle CNS stimulation Blood vessels: vasoconstriction to nonessential organs GI: relax smooth muscle and decrease motility Liver: glyconeogenesis Bladder: contraction Uterus: contraction Pupils: dilation Medication example: Pseudoephedrine to treat nasal congestion by vasoconstriction	Relax smooth muscle Vasodilation Bladder: Increase urine flow Medication example: Tamsulosin to improve urine flow
Alpha-2	Vasodilation Medication Example: Clonidine to treat hypertension	Not used clinically

Beta-1	Primarily stimulates heart with increased heart rate and contractility Also causes kidneys to release renin Medication example: Dobutamine to treat acute heart failure to increase cardiac output	"Selective Beta blocker" used to decrease heart rate and blood pressure Medication example: Metoprolol to decrease heart rate and blood pressure
Beta-2	Primarily relax smooth muscle Blood vessels: vasodilation Lungs: bronchodilation GI: decreased motility Liver: glyconeogenesis Uterus: relaxation Medication example: Albuterol for bronchodilation	"Nonselective Beta Blockers" block Beta-1 and Beta-2 receptors so also cause bronchoconstriction Medication example: Propranolol blocks Beta-1 and Beta-2 receptor so lowers blood pressure but inadvertently causes bronchoconstriction

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=822#h5p-9

Adrenergic Agonists

Adrenergic agonists stimulate Alpha-1, Alpha-2, Beta-1, or Beta-2 receptors. Stimulation of each type of receptor has different effects and are further explained below.

Alpha-1 receptor agonists: Stimulation of Alpha-1 receptors causes vasoconstriction in the periphery, which increases blood pressure. Vasoconstriction also occurs in mucus membranes, which decreases swelling and secretions for patients experiencing upper respiratory infections. Examples of Alpha-1 agonist medications are pseudoephedrine or phenylephrine, used to treat nasal congestion.

Alpha-2 receptor agonists: Stimulation of Alpha-2 receptors reduces CNS stimulation and is primarily used as an antihypertensive or a sedative. An example of an Alpha-2 agonist medication is clonidine, which is used to treat hypertension and is also used to treat attention deficit hyperactivity disorder.

Beta-1 receptor agonists: Stimulation of Beta-1 receptors primarily affects the heart by increasing heart rate and contractility. It also causes the kidneys to release renin. Effects on the heart are described as having a positive **chronotropic** (increases heart rate), positive **inotropic** (increases force of contraction), and positive **dromotropic** (increases speed of conduction between SA and AV node) properties. Medications that stimulate Beta-1 receptors are primarily used during cardiac arrest, acute heart failure,

or shock. An example of a Beta-1 receptor agonist medication is dobutamine, which is used to increase cardiac output in someone experiencing acute heart failure or shock. See Figure 4.7
"2018 Conduction System of Heart.jpg" by OpenStax College is licensed under CC BY 3.0
illustrating dromotropic properties of stimulating Beta-1 receptors.

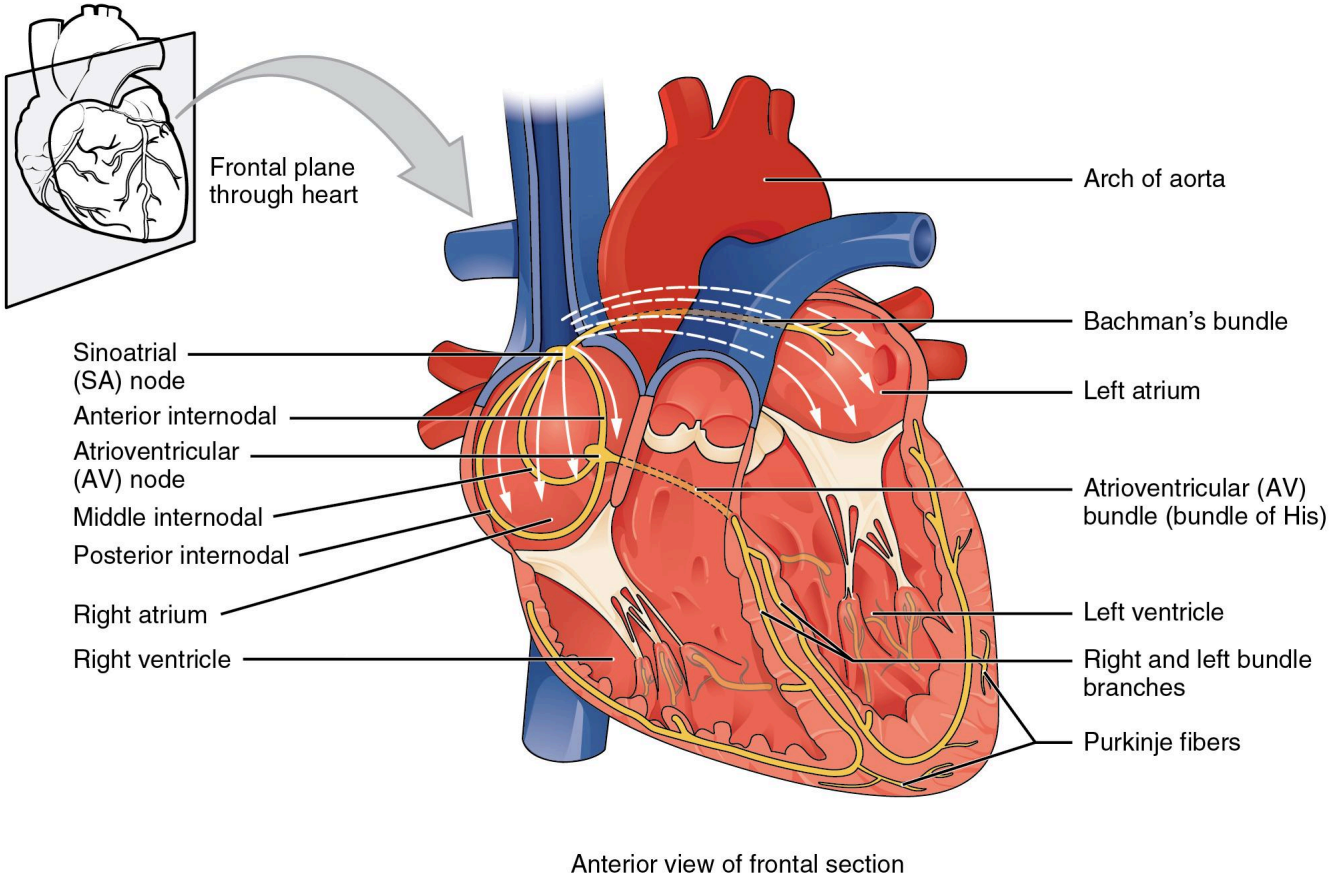


Figure 4.7 Dromotropic Properties Affect the Speed of Conduction Between SA and AV Nodes

Beta-2 receptor agonists: Stimulation of Beta-2 receptors causes relaxation in smooth muscle in the lungs, GI, uterus, and liver. Medications that stimulate Beta-2 receptors are primarily used to promote bronchodilation, which opens the airway, and are often used to treat patients with asthma or chronic obstructive pulmonary disease (COPD). An example of a Beta-2 receptor agonist medication used in asthma is albuterol. See Figure 4.8
"Bronchodilators" by BruceBlaus is licensed under CC BY 4.0
for an illustration of the effects of stimulating Beta-2 receptors in the lungs.

Side effects of Beta-2 receptor agonists are related to stimulation of Beta-2 receptors in other locations in the body. For example, albuterol can cause tachycardia by stimulating Beta-2 receptors in the heart. Stimulation of Beta-2 receptors can also inadvertently cause **hyperglycemia** in patients with diabetes because of activation of Beta-2 receptors in the liver, causing **glycogenolysis**.

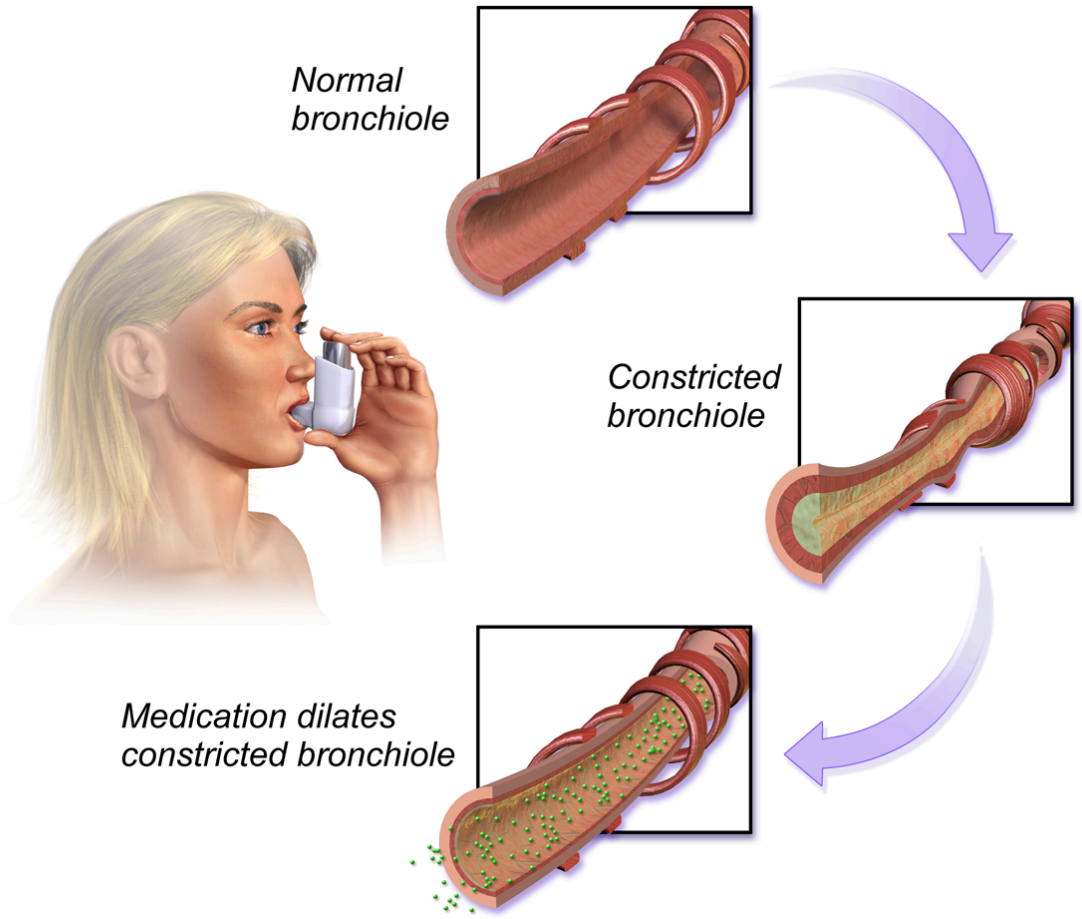


Figure 4.8 Effects of Medications Stimulating Beta 2 Receptors in the Lungs

Adrenergic Antagonists

Adrenergic antagonist medications inhibit the Alpha-1, Alpha-2, Beta-1, and Beta-2 receptors. The effects of inhibition of each receptor are explained further below.

Alpha-1 antagonists: Alpha-1 antagonists are primarily used to relax smooth muscle in the bladder and cause vasodilation.

Examples include:

- Tamsulosin is used to decrease resistance of an enlarged prostate gland and improve urine flow.
- Prazosin is used to cause vasodilation and decrease blood pressure in patients with hypertension.

Alpha-2 antagonists: This classification is used in research, but has limited clinical application.

Beta Antagonists: There are two types of beta antagonists: **selective beta blockers**, which inhibit Beta-1 receptors and affect the heart only, and **nonselective beta blockers,** that block both Beta-1 and Beta-2 receptors, thus affecting both the heart and lungs. Beta blockers are also referred to as having negative chronotropic (decreased heart rate), negative inotropic (decreased force of contraction), and negative dromotropic (decreased speed of conduction between SA and AV nodes) properties. It is also important for a nurse to remember that beta blockers can mask the usual hypoglycemic symptoms of tremor,

tachycardia, and nervousness in patients with diabetes.

Beta-1 antagonists: Beta-1 antagonists primarily block receptors in the heart, causing decreased heart rate and decreased blood pressure. An example is metoprolol, a selective beta blocker used to treat high blood pressure, chest pain due to poor blood flow to the heart, and several conditions involving an abnormally fast heart rate.

Beta-2 antagonists: Nonselective beta blockers block Beta-1 receptors and Beta-2 receptors in the lungs. An example is propranolol, which is used to lower blood pressure by decreasing the heart rate and cardiac output. However, it can also cause bronchoconstriction by inadvertently blocking Beta-2 receptors, so it must be used cautiously in patients with asthma or COPD.

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=822#h5p-10

Parasympathetic Nervous System

Acetylcholine (ACh) stimulates nicotinic and muscarinic receptors. Drugs that stimulate nicotinic and muscarinic receptors are called cholinergics. Medications are primarily designed to stimulate muscarinic receptors. Nicotine stimulates pre- and post-ganglionic nicotinic receptors, causing muscle relaxation and other CNS effects. An example of a medication designed to stimulate nicotinic receptors is the nicotine patch, used to assist with smoking cessation.

Muscarinic agonists are also called **parasympathomimetics** and primarily cause smooth muscle contraction, resulting in decreased heart rate, bronchoconstriction, increased gastrointestinal/ genitourinary tone, and pupillary constriction. There are two types of muscarinic agonists: direct-acting and indirect-acting. Direct-acting agonists bind to the muscarinic receptor. Indirect-acting muscarinic agonists work by preventing the breakdown of ACh, thus increasing the amount of acetylcholine available to bind receptors.

Examples of direct-acting muscarinic agonist medications include:

- Pilocarpine**:** Used to treat glaucoma by causing the ciliary muscle to contract and allow for the drainage of aqueous humor
- Bethanechol**:** Used for urinary retention by stimulating the bladder causing urine output

Examples of indirect-acting muscarinic agonist medications include:

- Pyridostigmine**:** Used to reverse muscle weakness in patients with myasthenia gravis
- Physostigmine**:** Used to treat organophosphate insecticide poisoning
- Donepezil**:** Enhances memory in some patients with early Alzheimer's disease

Muscarinic antagonists are referred to as **anticholinergics** or "parasympatholytics." Anticholinergics inhibit ACh and allow the SNS to dominate, creating similar effects as adrenergics. Their overall use is to relax smooth muscle. "SLUDGE" is a mnemonic commonly used to recall the effects of anticholinergics: **S**alivation decreased, **L**acrimation decreased, **U**rinary retention, **D**rowsiness/dizziness, **GI** upset, **E**yes (blurred vision/dry eyes). Anticholinergics may also cause confusion and constipation

and must be used cautiously in the elderly. See Figure 4.9

for an illustration of the **"SLUDGE"** effects of anticholinergics.

Examples of anticholinergic medications include:

- Atropine**:** Specific anticholinergic responses are dose-related. Small doses of atropine inhibit salivary and bronchial secretions and sweating; moderate doses dilate the pupil, inhibit accommodation, and increase the heart rate (vagolytic effect); larger doses will decrease motility of the gastrointestinal (GI) and urinary tracts; very large doses will inhibit gastric acid secretion
- Oxybutynin**:** Relaxes overactive bladder
- Benztropine**:** Reduces tremor and muscle rigidity in Parkinson's disease or in treatment of extrapyramidal reactions from antipsychotic medications
- Scopolamine**:** Decreases GI motility and GI secretions; used for motion sickness and post-operative nausea and vomiting

McCuistion, L., Vuljoin-DiMaggio, K., Winton, M, & Yeager, J. (2018). *Pharmacology: A patient-centered nursing process approach*. Elsevier.

,

Gersch, C., Heimgartner, N., Rebar, C., & Willis, L. (Eds.). (2017). P*harmacology made incredibly easy*. Wolters Kluwer.

,

Lilley, L., Collins, S., & Snyder, J. (2014). *Pharmacology and the Nursing Process*. Elsevier.

,

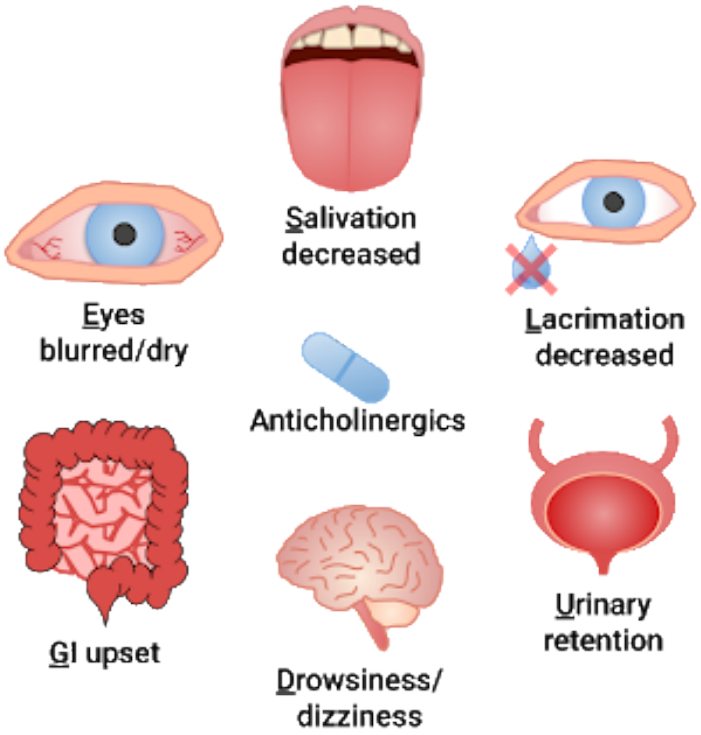


Fig 4.9. “SLUDGE” Effects of Anticholinergics: Salivation decreased, Lacrimation decreased, Urinary retention, Drowsiness/Dizziness, GI upset, Eyes (blurred vision/dry eyes). Also may cause confusion and constipation

4.3 Using the Nursing Process with ANS Medications

Open Resources for Nursing (Open RN)

Assessment

Many types of medications stimulate or inhibit specific ANS receptors. By memorizing the effects, it becomes easy for the nurse to recognize side effects resulting from the stimulation or inhibition of ANS neuroreceptors. Medications that stimulate ANS receptors often impact the heart, lungs, and blood vessels, so the nurse must often monitor blood pressure, heart rate, and lung sounds carefully for expected therapeutic effects and side effects. Anticholinergics cause muscle relaxation and can cause urinary retention, constipation, and dry mouth. The nurse should anticipate and assess for these side effects, and manage them as needed for patient comfort.

Planning

Common goals include:

Patient will adhere to the drug regimen.

Patient's vital signs will be within the desired range.

Implementation of Interventions

A nurse should be aware of parameters to administer or withhold medications affecting the autonomic nervous system. If the order parameters are unclear, the nurse should withhold the medication following safe administration guidelines, and notify the prescriber. For example, when no parameters are provided, blood pressure medications should not be administered if the patient's apical heart rate is less than 60 beats per minute and/or the systolic blood pressure is less than 100 mmHg.

Report any marked vital signs changes or suspected adverse effects.

Implement fall precautions, when needed, based on anticipated side effects of ANS medications.

Evaluation

It is always important for nurses to know the reason why a medication is ordered for a specific patient, so evaluation of therapeutic effectiveness can be documented. For example, if the purpose of medication is to improve urine flow, then improvement should be seen and documented. Otherwise, the side effects may not warrant the use of the medication.

4.4 ANS Medication Classes and Nursing Considerations

Open Resources for Nursing (Open RN)

Classes of medication, categorized according to neuroreceptor, are further discussed in more detail below. Table 4.2

contrasts agonist and antagonist medications for each ANS neuroreceptor.

Table 4.2 Comparison of Prototype Medications that Stimulate Versus Inhibit PNS and SNS Receptors

Receptor	Stimulation (Agonist)	Inhibition (Antagonist)
Nicotine	Nicotine is a muscle relaxant with CNS effects. **Nicotine patch** is used for nicotine addiction by slowly reducing dose and avoiding withdrawal effects	Not clinically applicable
Muscarinic	**Pilocarpine** causes muscle contraction; assists with glaucoma by contracting ciliary muscle and draining fluid	**Atropine** in small doses inhibits secretions; in moderate doses increases heart rate; in large doses decreases gastrointestinal motility

Alpha-1	**Pseudoephedrine** and **Phenylephrine** cause vasoconstriction, decreased swelling of mucus membranes, and decreased secretions	**Tamsulosin** relaxes smooth muscle in bladder/prostate to improve urine flow and also decreases blood pressure due to vasodilation
Alpha-2	**Clonidine** decreases CNS outflow to treat ADHD and also reduces blood pressure and heart rate	Limited clinical use
Beta-1	**Dobutamine** increases heart rate, force of heart contraction, and speed of conduction between SA to AV nodes	**Selective B blocker: Metoprolol** works on Beta-1 receptors to decrease blood pressure and heart rate
Beta-2	**Albuterol** used for bronchodilation	**Nonselective B blocker: Propranolol** works on Beta-2 and Beta-1 receptors; decreases blood pressure but can also cause bronchoconstriction
Catecholamines stimulate multiple adrenergic receptors	**Epinephrine** and **Norepinephrine**: stimulate alpha- and beta-receptors on target organs, causing increased heart rate and vasoconstriction for improved blood flow to essential organs **Dopamine** has dose-dependent effects that target arteries in the kidneys, heart, and brain	Not clinically applicable

Supplementary Videos: See the supplementary videos below related to sympathetic and parasympathetic nervous system medications.

Sympathetic Nervous System Drugs

Forciea, B. (2018, January 12). Sympathetic nervous system drugs. [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/-e_s-jTPtm4

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=823#oembed-1

Parasympathetic Nervous System Drugs

Forciea, B. (2018, February 2). Parasympathetic nervous system drugs. [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/ZSRk_NkbBPg

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=823#oembed-2

4.5 Nicotine Receptor Agonists

Open Resources for Nursing (Open RN)

Nicotine binds to and activates nicotinic acetylcholine receptors, mimicking the effect of acetylcholine at these receptors.

Indications: Nicotine patches are used as an aid to smoking cessation and for the relief of nicotine withdrawal signs and symptoms as part of a comprehensive behavioral smoking cessation program.

Nursing Considerations: Nicotine is a hazardous drug; use safe handling and disposal precautions. Apply one new patch every 24 hours on skin that is dry, clean, and hairless. Remove backing from patch and immediately press onto skin. Hold for 10 seconds. Wash hands after applying or removing the patch. Save pouch to use for patch disposal. Dispose of the used patches by folding sticky ends together and putting in pouch. The used patch should be removed and a new one applied to a different skin site at the same time each day. Do not wear more than one patch at a time. Discontinue use and call provider if an allergic reaction occurs, such as difficulty breathing or rash, or symptoms of nicotine overdose occur, such as nausea, vomiting, dizziness, weakness, and rapid heartbeat. It may also cause vivid dreams or sleep disturbances. If these occurrences occur, patients should be counseled to remove the patch at bedtime and apply a new one in the morning.

Patient Teaching & Education: Emphasize that the patient should stop smoking completely while on nicotine replacement therapy to avoid additive nicotine levels higher than smoking alone. Advise patients that participating in a comprehensive smoking cessation program improves success. If using a nicotine patch, patients should be aware that skin sensitivity at the site of patch placement typically resolves within one hour.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Alert: Advise patient to keep all nicotine products, including used inhaler cartridges, nasal spray bottles, and patches out of the reach of children and pets.

Now let's take a closer look at the medication grid on nicotine patch in Table 4.5.

Medication grids assist students to learn key points about each medication class. Basic information related to a common generic medication in this class is outlined, including administration considerations, therapeutic effects, and side effects/adverse effects. Prototype/generic medication listed in the medication grid is also hyperlinked directly to a free resource from the U.S. National Library of Medicine called Daily Med. Because information about medication is constantly changing, nurses should always consult evidence-based resources to review current recommendations before administering specific medication.

Table 4.5 Nicotine Patch Medication Grid

Class/	Prototype/	Administration Considerations	Therapeutic Effects	Side/Adverse Effects

Subclass	Generic			
		Hazardous drug; use safe handling and disposal precautions Check for allergy to adhesives See administration guidelines in packaging Use cautiously in patients with recent myocardial infarction, serious arrhythmias, coronary artery disease, severe or worsening angina, hypertension, vasospastic diseases, or peripheral vascular disease Patients taking monoamine oxidase inhibitors (MAOIs) require lower dosage Can cause fetal harm		
Nicotinic Agonist	nicotine patch		Used for nicotine addiction by slowly reducing dose and avoiding withdrawal effects	Discontinue use and call provider if: -Allergic reaction such as difficulty breathing or rash -Irregular heartbeat or palpitations -Symptoms of nicotine overdose such as nausea, vomiting, dizziness, weakness, and rapid heartbeat

4.6 Muscarinic Receptor Agonists

Open Resources for Nursing (Open RN)

Pilocarpine is a muscarinic receptor agonist.

Mechanism of Action: Pilocarpine causes the ciliary muscle to contract, allowing for the drainage of aqueous humor from the anterior chamber of the eye and reducing intraocular pressure related to glaucoma.

Indication: Pilocarpine is used to treat glaucoma.

Nursing Considerations: Remove contact lens before administration. Apply light finger pressure on lacrimal sac for 2 minutes after instilling to minimize systemic absorption.

Patient Teaching & Education: Advise the patient to use caution with night driving. Additionally, use of this medication can cause hypotension.

Now let's take a closer look at the medication grid on pilocarpine in Table 4.6.

Table 4.6 Pilocarpine Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Muscarinic Agonist	**pilocarpine**	Remove contact lens before administration Apply light finger pressure on lacrimal sac for 2 minutes after instilling to minimize systemic absorption	Controls intraocular pressure in glaucoma	Caution with night driving

4.7 Muscarinic Antagonists

Open Resources for Nursing (Open RN)

Atropine is a muscarinic antagonist.

Mechanism of Action: Specific anticholinergic responses are dose-related. Small doses of atropine inhibit salivary and bronchial secretions and sweating. Moderate doses dilate the pupil, inhibit accommodation, and increase the heart rate (vagolytic effect). Large doses decrease motility of the gastrointestinal and urinary tracts, and very large doses will inhibit gastric acid secretion.

Indications: Varying dosages are used preoperatively to diminish secretions, to stimulate the heart rate in conditions causing bradycardia, or to treat muscarinic symptoms of insecticide (organophosphorus or carbamate) poisoning or mushroom poisoning.

Nursing Considerations: As with all anticholinergics, use with caution with the elderly, because elderly patients may react with agitation or drowsiness. Heat stroke may occur in the presence of high temperatures. Immediately report symptoms of overdose: urine retention, abnormal heartbeat, dizziness, passing out, difficulty breathing, weakness, or tremors. Physostigmine has been used to reverse anticholinergic effects.

Patient Teaching & Education: Advise patients that use of these medications may cause dizziness and drowsiness, so patients should be aware of potential impact on their level of alertness. Additionally, use of medications may cause dry mouth, and frequent oral hygiene is encouraged. The use of atropine may cause urinary retention in males with benign prostatic hypertrophy (BPH).
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on atropine in Table 4.7.

Table 4.7 Atropine Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Muscarinic Antagonist	**atropine**	Use with caution with elderly Contraindicated in high environmental temperatures	Dose dependent: small dose inhibits secretions; moderate dose increases heart rate; large dose decreases gastrointestinal motility	Immediately report symptoms of overdose: urine retention, abnormal heartbeat, dizziness, passing out, difficulty breathing, weakness, or tremors

4.8 Alpha-1 Agonists

Open Resources for Nursing (Open RN)

Pseudoephedrine and phenylephrine are Alpha-1 agonists.

Mechanism of Action: Alpha-1 agonists stimulate alpha receptors in the respiratory tract, causing constriction of blood vessels and shrinkage of swollen nasal mucous membranes, thus increasing airway patency and reducing nasal congestion.

Indication: These drugs are commonly used for symptomatic relief in upper respiratory infections.

Nursing Considerations: Pseudoephedrine has had recent limitations placed on its use because it is a common ingredient in the illicit manufacturing of the drug methamphetamine. Pharmacies now require individuals to provide identification to purchase pseudoephedrine and must track the number of purchases. As a result, most over-the-counter decongestants now contain phenylephrine. Both should be used cautiously in patients with glaucoma, hypertension, or an enlarged prostate gland and are contraindicated in patients taking monoamine oxidase inhibitors (MAOIs), an older class of medication used to treat depression. Monitor for elevated blood pressure, urinary retention, nervousness, or difficulty sleeping. Do not administer within 2 hours of bedtime.

Patient Teaching & Education: Patients should be instructed to take medication as prescribed and be careful not to double doses. If they experience nervousness, breathing difficulties, or heart rate changes, they should notify their healthcare provider.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on phenylephrine and pseudoephedrine in Table 4.8.

Table 4.8 Phenylephrine and Pseudoephedrine Medication Grid

Class/ Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Alpha-1 agonist	**phenylephrine** **pseudoephedrine**	Contraindicated with MAOIs Use cautiously in patients with glaucoma, hypertension, or enlarged prostate Do not administer within 2 hours of bedtime	Decreased swelling of mucous membranes and decreased secretions	Increased blood pressure Urinary retention Nervousness Difficulty sleeping

4.9 Alpha-1 Antagonists

Open Resources for Nursing (Open RN)

Tamsulosin is an Alpha-1 antagonist.

Mechanism of Action: Tamsulosin selectively blocks alpha receptors in the prostate, leading to the relaxation of smooth muscles in the bladder, neck, and prostate, thus improving urine flow and reducing symptoms of benign prostatic hypertrophy (BPH).

Indications: Tamsulosin is used to treat BPH.

Nursing Considerations: Avoid using with other alpha-blockers. Tamsulosin is contraindicated with strong CYP3A4 inhibitors such as ketoconazole. Assess and monitor blood pressure, especially after first dose because tamsulosin may cause orthostatic hypotension.

Patient Teaching & Education: Advise patients to change positions slowly because the drug may cause orthostatic blood pressure changes. Additionally, the patient should take the medication at the same time each day. The patient should follow up with their healthcare provider to assess the effectiveness of the medication.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on tamsulosin in Table 4.9.
This work is a derivative of Daily Med by U.S. National Library of Medicine in the public domain.

Table 4.9 Tamsulosin Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Alpha-1 antagonist	**tamsulosin**	Avoid using with other alpha-blockers Assess and monitor blood pressure, especially after first dose	Relaxes smooth muscle in bladder/prostate to improve urine flow	Hypotension, especially after first dose. Advise patient to change positions slowly

4.10 Alpha-2 Agonist

Open Resources for Nursing (Open RN)

Clonidine is an Alpha-2 agonist

Mechanism of Action: Clonidine reduces sympathetic outflow from the central nervous system and decreases peripheral resistance and renal vascular resistance.

Indications: Clonidine is used to treat hypertension (HTN) and attention deficit hyperactivity disorder (ADHD).

Nursing Considerations: Monitor blood pressure and pulse rate frequently. Dosage is usually adjusted to the patient's blood pressure and can cause hypotension, bradycardia, and sedation. Rebound hypertension may occur if stopped abruptly.

Patient Teaching & Education: Patients should be taught the importance of adhering to the same dosing schedule each day. Patients may experience orthostatic blood pressure changes and should be cautioned against the use of alcohol while taking this medication. Additionally, patients may experience increased susceptibility to blood pressure changes when exercising and exposed to hot environments. If the patient experiences mental depression as a side effect of the medication, a different medication therapy may be needed.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on clonidine in Table 4.10.

Table 4.10 Cloinidine Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Alpha-2	**clonidine**	Monitor blood pressure and pulse	Treat hypertension	Hypotension

	rate frequently		Bradycardia
agonist	Dosage is usually adjusted to patient's BP and tolerance	or ADHD	Sedation Rebound hypertension if stopped abruptly

Alpha-2 Antagonists

A2 antagonists are used in research with limited clinical application.

4.11 Beta-1 Agonists

Open Resources for Nursing (Open RN)

Dobutamine is a Beta-1 agonist.

Mechanism of Action: Dobutamine stimulates Beta-1 receptors to increase heart rate, force of contraction, and conduction velocity.

Indications: Dobutamine is used to treat cardiogenic shock and severe heart failure to increase contractility and cardiac output.

Nursing Considerations: In IV administration, dilute concentration before administering. Continuously monitor electrocardiogram (ECG), blood pressure, cardiac output, and urine output during therapy. This drug can cause a marked increase in heart rate and blood pressure. Report all adverse reactions promptly, especially labored breathing, angina, palpitations, and dizziness.

Patient Teaching & Education: The patient should be instructed to inform the nurse immediately if they notice chest pain, shortness of breath, or numbness or tingling in the extremities.

Now let's take a closer look at the dobutamine medication grid in Table 4.11.

Table 4.11 Dobutamine Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Beta-1 agonist	**dobutamine**	Continuously monitor ECG, blood pressure, cardiac	Increases heart rate, force of heart contraction, and	Marked increase in heart rate and blood

			pressure
	output, and urine output during therapy	speed of conduction between SA to AV nodes	Report all adverse reactions promptly, especially labored breathing, angina, palpitations, and dizziness

4.12 Beta-1 Antagonists

Open Resources for Nursing (Open RN)

Metoprolol is a selective Beta-1 antagonist.

Mechanism of Action: Metoprolol primarily blocks Beta-1 receptors in the heart, causing decreased heart rate and decreased blood pressure. However, higher doses can also block Beta-2 receptors in the lungs, causing bronchoconstriction.

Indications: Metoprolol is commonly used to treat high blood pressure, chest pain due to poor blood flow to the heart, as an early intervention during a myocardial infarction (MI), and in several heart conditions involving an abnormally fast heart rate.

Nursing Considerations: Don't crush extended-release (ER) formulations. Always check patient's apical pulse rate before giving drug. Withhold the drug and call the prescriber immediately if the heart rate is slower than 60 beats/minute, unless other parameters are provided. In diabetic patients, monitor glucose level closely because the drug masks common signs and symptoms of hypoglycemia. The most serious potential adverse effects are shortness of breath, bradycardia, and worsening heart failure. Other adverse effects include fatigue, dizziness, depression, insomnia, nightmares, gastrointestinal upset, erectile dysfunction, dyspnea, and wheezing.

Black Box Warning: When stopping therapy, the dosage should be tapered over 1 to 2 weeks because abrupt discontinuation may cause chest pain or myocardial infarction (MI).

Patient Teaching & Education: Patients should be instructed to take the medication as prescribed. They should be advised that abrupt cessation of medication therapy may result in life-threatening cardiac arrhythmias. Patients should also be taught how to self-check pulse and blood pressure to assess the effectiveness of medication therapy. Additionally, they should be cautioned against sudden changes in position due to orthostatic blood pressure changes. Patients may experience increase sensitivity to cold and should be cautioned to avoid caffeinated substances.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on metoprolol in Table 4.12.

Table 4.12 Metoprolol Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Beta-1 antagonist	Selective B blocker: **metoprolol**	Do not crush extended-release (ER) formulations Always assess apical HR and if less than 60, do not administer and call the prescriber unless other parameters are provided Monitor blood sugar in diabetic patients because drug can mask symptoms of hypoglycemia	Decreases blood pressure or controls rapid heart rate	Decreased blood pressure or heart rate Most serious: -Hypotension -Bradycardia -Worsening heart failure (HF) Other: -CNS: fatigue, dizziness, depression, insomnia, nightmares -GI upset -GU: erectile dysfunction -Respiratory: dyspnea and wheezing

4.13 Beta-2 Agonists

Open Resources for Nursing (Open RN)

Albuterol is a Beta-2 agonist.

Mechanism of Action: Albuterol is a selective Beta-2 agonist primarily used to cause bronchodilation in the lungs. However, Beta-2 receptors in the heart can also be stimulated, causing cardiovascular side effects.

Indications: Albuterol is commonly used to treat asthma and chronic obstructive pulmonary disease

(COPD).

Nursing Considerations: Monitor respiratory rate, oxygen saturation, and lungs sounds before and after administration. If more than one inhalation is ordered, wait at least 2 minutes between inhalations. Use a spacer device to improve drug delivery, if appropriate.

Adverse Effects: Albuterol can cause hypersensitivity or paradoxical bronchospasm. It can also produce a clinically significant cardiovascular effect in some patients by causing increased heart rate and blood pressure, which may require the drug to be discontinued.

Patient Teaching & Education: Patients should remain compliant with the medication dosing regimen. Individuals should contact their healthcare provider if they experience ongoing shortness of breath unrelieved with medication therapy. If using an inhaler, the patient should be sure to prime the inhaler prior to administering the dose of medication. The medication can cause an unusual taste in the mouth, so patients should rinse their mouth with water after each use.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on albuterol in Table 4.13.

Table 4.13 Albuterol Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Beta-2 agonist	**albuterol**	If more than 1 inhalation is ordered, wait at least 2 minutes between inhalations Use spacer device to improve drug delivery, if appropriate	Bronchodilation in asthma or COPD	Hypersensitivity Can cause paradoxical bronchospasm Report significantly increased heart rate and blood pressure, which may require the drug to be discontinued

4.14 Beta-2 Antagonists

Open Resources for Nursing (Open RN)

Propranolol is a Beta-2 antagonist.

Mechanism of Action: Propranolol is a nonselective beta blocker because of its inhibition of both Beta-1 and Beta-2 receptors.

Indications: Propranolol is used to treat high blood pressure, angina, various heart dysrhythmias (to lower the heart rate), and essential tremors. It is also used after a myocardial infarction to reduce mortality by decreasing heart workload, and in migraine prevention.

Nursing Considerations: Nonselective beta blockers must be used cautiously with patients who have co-existing asthma or chronic obstructive pulmonary disease (COPD) because of the effects on Beta-2 receptors that could potentially cause bronchoconstriction. It can also mask symptoms of hypoglycemia in diabetics. Use with caution in patients with impaired hepatic or renal function. Give immediate-release (IR) formulations on an empty stomach. Do not crush extended-release (ER) formulations. Propranolol ER is not considered a simple milligram-for-milligram substitute for conventional propranolol. Check blood pressure and apical pulse before giving drug; withhold and notify prescriber if apical pulse is less than 60 beats per minute or systolic blood pressure is less than 100 mm Hg, unless other parameters are provided. During IV administration, monitor blood pressure, ECG, and heart rate frequently. The most serious adverse effects include bronchoconstriction, hypotension, bradycardia, and signs of worsening heart failure. Other adverse effects are similar to selective beta blockers like metoprolol. Black Box Warning: Abrupt withdrawal of this drug may cause exacerbation of angina or a myocardial infarction. To discontinue this drug, gradually reduce dosage over 1 to 2 weeks.

Patient Teaching & Education: Patients should be instructed to follow the medication dosing regimen. Stopping medication therapy abruptly may cause life-threatening arrhythmias. Patients should be instructed on how to self-assess pulse and blood pressure to evaluate medication effectiveness. The medication may cause increased susceptibility to orthostatic blood pressure changes and increased sensitivity to cold.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on propranolol in Table 4.14.

Table 4.14 Propranolol Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Beta-2 Antagonist	Nonselective B-blocker: **propranolol**	Contraindicated in patients with asthma, COPD, or bradycardia Use cautiously in patients who have diabetes mellitus because drug masks some symptoms of hypoglycemia Use with caution in patients with impaired hepatic or renal function	Decrease blood pressure and heart rate Prevent migraines Manage tremors	Most serious: -Bronchoconstriction -Hypotension -Bradycardia -Worsening heart failure Black Box Warning: Abrupt

	Give immediate release formulations on an empty stomach	
	Do not crush ER formulations	withdrawal of drug may cause exacerbation of angina or myocardial infarction. To discontinue drug, gradually reduce dosage over 1 to 2 weeks
	Check BP and apical pulse before giving drug; withhold and notify prescriber if apical pulse is less than 60 or systolic blood pressure is less than 100 unless other parameters are provided	Other adverse effects similar to metoprolol
	During IV administration, monitor blood pressure, ECG, and heart rate frequently	

4.15 Alpha and Beta Receptor Agonists (Catecholamines)

Open Resources for Nursing (Open RN)

Catecholamines

Epinephrine and norepinephrine (NE) are adrenergics that stimulate the beta and alpha receptors on the target cell. Dopamine has dose-dependent effects on targeted arteries in the kidneys, heart, and brain.

Epinephrine (Alpha and Beta Receptor Agonist): Epinephrine acts on both alpha- and beta-adrenergic receptors and is used in several routes including intravenously (IV), subcutaneously, intramuscularly, and via inhalation. Epinephrine decreases vasodilation and increases vascular permeability through its alpha-adrenergic receptor action, which can lead to loss of intravascular fluid volume and hypotension. Through its action on beta-adrenergic receptors, epinephrine causes bronchial smooth muscle relaxation and helps alleviate bronchospasm, wheezing, and dyspnea that may occur during anaphylaxis.

Indications: Epinephrine is used for severe allergic reactions, acute bronchospasm during asthma attacks, cardiac resuscitation, hypotension in severe shock, or for local injection to control superficial bleeding.

Nursing Considerations: Epinephrine is contraindicated for use in fingers, toes, ears, nose, or genitalia when used with local anesthetic due to the vasoconstrictive action. Contraindicated in patients with narrow angle glaucoma. Administer with caution to the elderly and those with pre-existing cardiovascular disease. When administering IV, monitor vitals (blood pressure, heart rate and respiratory rate) and cardiovascular and respiratory systems closely; if blood pressure increases sharply, give rapid-

acting vasodilators. Monitor IV site for extravasation. Discard IV solution if discolored.

Patient Teaching & Education with EpiPen: Epinephrine formulated in a pen for injection is known as EpiPen. EpiPen is used for severe allergic reactions after exposure to an allergen like a bee sting. Check expiration date, store at room temperature, and protect from light. Effects fade after 15-20 minutes, so seek medical care immediately.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Norepinephrine is another catecholamine, and is used as a peripheral vasoconstrictor (due to alpha-adrenergic action) and as an inotropic stimulator of the heart and dilator of coronary arteries (due to beta-adrenergic action) in patients with critically low blood pressure.

Now let's take a closer look at the medication grid on epinephrine and norepinephrine in Table 4.15a.

Table 4.15a Epinephrine and Norepinephrine Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Catecholamine	**epinephrine** **norepinephrine**	Contraindicated for use in fingers, toes, ears, nose, or genitalia when used with local anesthetic Monitor vitals (blood pressure, heart rate, respiratory rate), cardiovascular and respiratory systems closely when administering IV If administering IV, monitor IV site for extravasation Discard IV solution if discolored	Reversal of severe allergic reaction, bronchodilation, increased blood pressure, cardiac resuscitation, or control of superficial bleeding	Hypertension Tachycardia

Dopamine is another type of catecholamine specifically used to improve perfusion of organs, improve cardiac output, and increase blood pressure.

Mechanism of Action: In low doses, dopamine mainly stimulates dopamine receptors and dilates the renal vasculature. Moderate doses of dopamine stimulate beta receptors for a positive inotropic effect. Higher doses also stimulate alpha receptors, constricting blood vessels and increasing blood pressure.

Indications: Dopamine is used to treat shock, improve perfusion to vital organs, increase cardiac output, and correct hypotension.

Nursing Considerations: During infusion, frequently monitor blood pressure, cardiac output, urine output, and color and temperature of limbs. If urine flow decreases without hypotension, notify prescriber because dosage may need to be reduced. Concurrent alpha or beta blockers can antagonize dopamine. Adverse effects include hypotension, tachycardia, palpitations, and decreased blood flow to the extremities.

Patient Teaching & Education: Patients should contact their health care provider immediately if experiencing unusual sweating, dizziness, heart palpitations, or chest pain.

Now let's take a closer look at the medication grid on dopamine in Table 4.15b.

Table 4.15b Dopamine Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Side/Adverse Effects
Catecholamine	**Dopamine**	During infusion, frequently monitor ECG, blood pressure, cardiac output, pulse rate, urine output, and color and temperature of limbs Check urine output often	Increased blood flow to kidneys causing increased urine output Increased cardiac output and elevated blood pressure	Hypotension Tachycardia Palpitations Dyspnea Decreased blood flow to extremities If urine flow decreases without hypotension, notify prescriber because dosage may need to be reduced

4.16 Module Learning Activities

Open Resources for Nursing (Open RN)

Image of lightbulb
Lightbulb Momentin a circle

Test your knowledge and application.

Practice applying your knowledge regarding ANS neuroreceptors to the following patient scenarios where a nurse must use clinical judgment for a solution:

1. A patient begins a nicotine patch in an attempt to stop smoking. The patient reports feelings of nausea, weakness, and a rapid heartbeat. What is the likely cause of these symptoms, and what is the nurse's best response?

2. A patient with benign prostatic hyperplasia (BPH) has a new order for tamsulosin. He asks, "How will tamsulosin help me? I already take so many pills."

a) What is the nurse's best response?

b) What does the nurse plan to monitor carefully, especially after administering the first dose of tamsulosin?

3. A patient with asthma is taking albuterol to help when she feels increased shortness of breath.

a) How will albuterol assist in her breathing?

The patient states, "After I take albuterol, it feels like my heart is racing."

b) What is the likely cause of this symptom?

c) What is the nurse's best response to the patient's concern?

4. A patient with high blood pressure is prescribed propranolol.

a) How will propranolol help to lower his blood pressure?

b) What will the nurse assess before administering the propranolol?

The nurse listens to the patient's lungs a few hours after administering propranolol and notices new wheezing.

c) What could be a potential cause of this new finding?

d) What is the nurse's next best response?

5. A patient is prescribed metoprolol to help control his atrial fibrillation, an irregular heart rhythm.

a) What will the nurse assess before administering the metoprolol?

b) What findings would cause the nurse to call the provider before administering the metoprolol?

Upon reassessment the next day, the nurse notices a new finding of edema in the patient's feet and lower legs.

c) What could be a potential cause of this new finding?

d) What is the nurse's next best response?

6. A patient with an acute episode of heart failure is admitted and is prescribed dobutamine.

a) How will dobutamine improve the patient's condition?

b) What will the nurse monitor carefully during administration?

Note: Answers to the Light Bulb Moment can be found in the "Answer Key" sections at the end of the book.

IV. Glossary

Open Resources for Nursing (Open RN)

Acetylcholine (ACh): Binds to both nicotinic receptors and muscarinic receptors in the PNS.

Adrenergic: Postganglionic neuron where neurotransmitters norepinephrine and epinephrine are released. Includes alpha (α) receptors and beta (β) receptors.

Adrenergic Agonist: Mimics the effects of the body's natural SNS stimulation on alpha (α) and beta (β) receptors. Also called sympathomimetics.

Adrenergic Antagonist: Blocks the effects of the SNS receptors.

Anticholinergics: Inhibit acetylcholine (ACh), which allows the SNS to dominate. Also called parasympatholytics or muscarinic antagonists. Overall use is to relax smooth muscle.

Autonomic Nervous System: Controls cardiac and smooth muscle, as well as glandular tissue; associated with involuntary responses.

Catecholamines: Include norepinephrine, epinephrine, and dopamine. Stimulate the adrenergic receptors.

Central Nervous System (CNS): Anatomical division of the nervous system located within the cranial

and vertebral cavities, namely the brain and spinal cord.

Cholinergic: Postganglionic neuron where acetylcholine (ACh) is released that stimulates nicotinic receptors and muscarinic receptors. Also relating to drugs that inhibit, enhance, or mimic the action of ACh.

Chronotropic: Drugs may change the heart rate and rhythm by affecting the electrical conduction system of the heart and the nerves that influence it, such as by changing the rhythm (increasing) produced by the sinoatrial node. Positive chronotropes increase heart rate; negative chronotropes decrease heart rate.

Dromotropic: Stimulation causes increases speed of conduction between SA and AV node.

Fight-or-Flight Response: The response when the SNS is stimulated, causing the main effects of increased heart rate, increased blood pressure, and bronchodilation.

Glycogenolysis: The breakdown of glycogen into glucose, causing elevated blood glucose.

Homeostasis (in ANS): Balance between the SNS and PNS. At each target organ, dual innervation determines activity. For example, SNS stimulation causes the heart rate to increase, whereas PNS stimulation causes the heart rate to decrease.

Hyperglycemia: Elevated blood glucose.

Inotropic: Stimulation causes increased force of contraction.

Involuntary Responses: Responses that the brain controls without the need for conscious thought.

Motor Neurons: Consist of the somatic nervous system that stimulates voluntary movement of muscles and the autonomic nervous system that controls involuntary responses.

Muscarinic Agonists: Also called parasympathomimetics. Primarily cause smooth muscle contraction, resulting in decreased HR, bronchoconstriction, increased gastrointestinal/genitourinary tone, and pupil constriction.

Neurons: Cells that carry electrical impulses to the synapse of a target organ.

Nonselective Beta Blockers: Medications that block both Beta-1 and Beta-2 receptors, thus affecting both the heart and lungs.

Parasympathetic Division (PNS): Includes nerves outside the brain and spinal cord. Associated with the “rest and digest” response. Stimulation of PNS causes decreased heart rate, decreased blood pressure via vasodilation, bronchial constriction, and stimulates intestinal motility, salivation, and relaxation of the bladder.

Parasympatholytics: Inhibit acetylcholine (ACh), which allows the SNS to dominate. Also called anticholinergics or muscarinic antagonists.

Parasympathomimetics: Also called muscarinic agonists. Primarily cause smooth muscle contraction,

resulting in decreased HR, bronchoconstriction, increased GI/GU tone, and pupil constriction.

Peripheral Nervous System (PNS): An anatomical division of the nervous system that is largely outside the cranial and vertebral cavities, namely all parts except the brain and spinal cord.

Postganglionic Neurons: Differ for the SNS and PNS branches. Postganglionic neurons of the autonomic system are classified as either cholinergic, meaning that acetylcholine (ACh) is released, or adrenergic, meaning that norepinephrine is released.

Preganglionic Neurons: All preganglionic neurons (in the SNS and PNS) release acetylcholine (ACh).

Selective Beta Blocker: Medications that mostly inhibit B1 receptors.

Sensory Neurons: Sense the environment and conduct signals to the brain that become a conscious perception of that stimulus.

"SLUDGE": Mnemonic for the effects of anticholinergics: **S**alivation decreased, **L**acrimation decreased, **U**rinary retention, **D**rowsiness/dizziness, **G**I upset, **E**yes (blurred vision/dry eyes).

Somatic Nervous System: Causes contraction of skeletal muscles; associated with voluntary responses.

Sympathetic Division (SNS): Associated with the "fight-or-flight response." Stimulation causes the main effects of increased heart rate, increased blood pressure via the constriction of blood vessels, and bronchodilation.

Sympathomimetics: Mimic the effects of the body's natural SNS stimulation of adrenergic receptors. Also called adrenergic agonists.

Synapse: The connection between the neuron and its target cell.

V

Respiratory

5.1 Respiratory Introduction

Open Resources for Nursing (Open RN)

Learning Objectives

- Identify the classifications and actions of respiratory system drugs
- Give examples of when, how, and to whom respiratory system drugs may be administered
- Identify the side effects and special considerations associated with respiratory system drugs
- Include considerations and implications of using respiratory system drugs across the lifespan
- Include evidence-based concepts when using the nursing process related to medications that affect the respiratory system

- Identify and interpret related laboratory tests

Every year millions of Americans visit their health care provider for respiratory diseases such as allergies, asthma, bronchitis, common cold, chronic obstructive pulmonary disease (COPD), and pneumonia.

Currently more than 25 million people in the United States have asthma. Approximately 14.8 million adults have been diagnosed with COPD, and approximately 12 million people have not yet been diagnosed. The burden of respiratory diseases affects individuals and their families, schools, workplaces, neighborhoods, cities, and states. Because of the cost to the health care system, the burden of respiratory diseases also falls on society; it is paid for with tax dollars, higher health insurance rates, and lost productivity. Annual health care expenditures for asthma alone are estimated at $20.7 billion.

Before we learn about medications that are used to treat respiratory conditions in our patients, let's review the respiratory system.

5.2 Respiratory Basics

Open Resources for Nursing (Open RN)

Basic Concepts Related to Respiratory Medications

Overview of the Respiratory System

The purpose of the respiratory system is to perform gas exchange. Pulmonary ventilation provides air to the alveoli for this gas exchange process. At the respiratory membrane where the alveolar and capillary walls meet, gases move across the membranes, with oxygen entering the bloodstream and carbon dioxide exiting. It is through this mechanism that blood is oxygenated and carbon dioxide, the waste product of cellular respiration, is removed from the body.

The major organs of the respiratory system function primarily to provide oxygen to body tissues for cellular respiration, remove the waste product carbon dioxide, and help maintain acid-base balance. Portions of the respiratory system are also used for non-vital functions, such as sensing odors, speech production, and for straining, such as during childbirth or coughing.

See Figure 5.1

illustrating major respiratory structures.

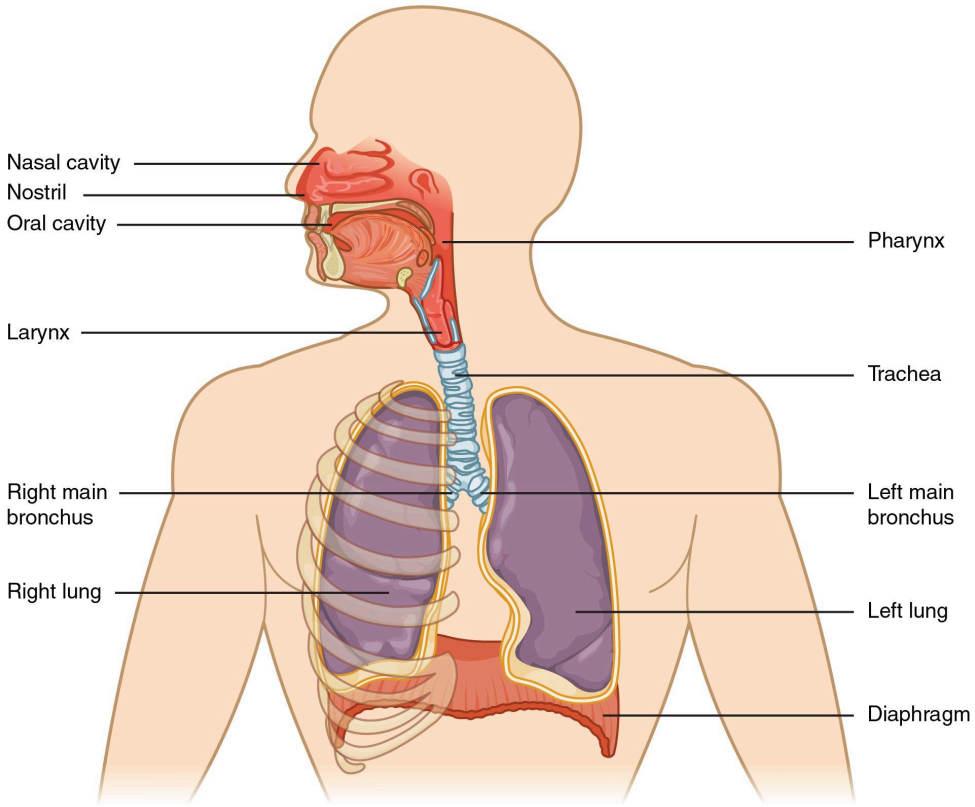


Figure 5.1 Major Respiratory Structures: The major respiratory structures span the nasal cavity to the diaphragm

Functionally, the respiratory system can be divided into a conducting zone and a respiratory zone. The conducting zone of the respiratory system includes the organs and structures not directly involved in gas exchange. The gas exchange occurs in the respiratory zone.

Conducting Zone

The major functions of the conducting zone are to provide a route for incoming and outgoing air, remove debris and pathogens from the incoming air, and warm and humidify the incoming air. Several structures within the conducting zone perform other functions as well. The epithelium of the nasal passages, for example, is essential to sensing odors, and the bronchial epithelium that lines the lungs can metabolize some airborne carcinogens.

The cilia of the respiratory epithelium help remove the mucus and debris from the nasal cavity with a constant beating motion, thus sweeping materials toward the throat to be swallowed. Interestingly, cold air slows the movement of the cilia, resulting in the accumulation of mucus that may, in turn, lead to a runny nose during cold weather. This moist epithelium functions to warm and humidify incoming air. Capillaries located just beneath the nasal epithelium warm the air by convection.

Bronchial Tree

The trachea branches into the right and left primary bronchi at the carina. A bronchial tree (or respiratory tree) is the collective term used for these multiple-branched bronchi. The main function of the bronchi, like other conducting zone structures, is to provide a passageway for air to move into and

out of each lung. In addition, the mucous membrane traps debris and pathogens.

A bronchiole branches from the tertiary bronchi. Bronchioles, which are about 1 mm in diameter, further branch until they become the tiny terminal bronchioles, which lead to the structures of gas exchange. There are more than 1,000 terminal bronchioles in each lung. The muscular walls of the bronchioles do not contain cartilage like those of the bronchi. This muscular wall can change the size of the tubing to increase or decrease airflow through the tube.

Respiratory Zone

In contrast to the conducting zone, the respiratory zone includes structures that are directly involved in **gas exchange**. See Figure 5.2

for an illustration of the respiratory zone. The respiratory zone begins where the terminal bronchioles join a respiratory bronchiole, the smallest type of bronchiole, which then leads to an alveolar duct, opening into a cluster of alveoli.

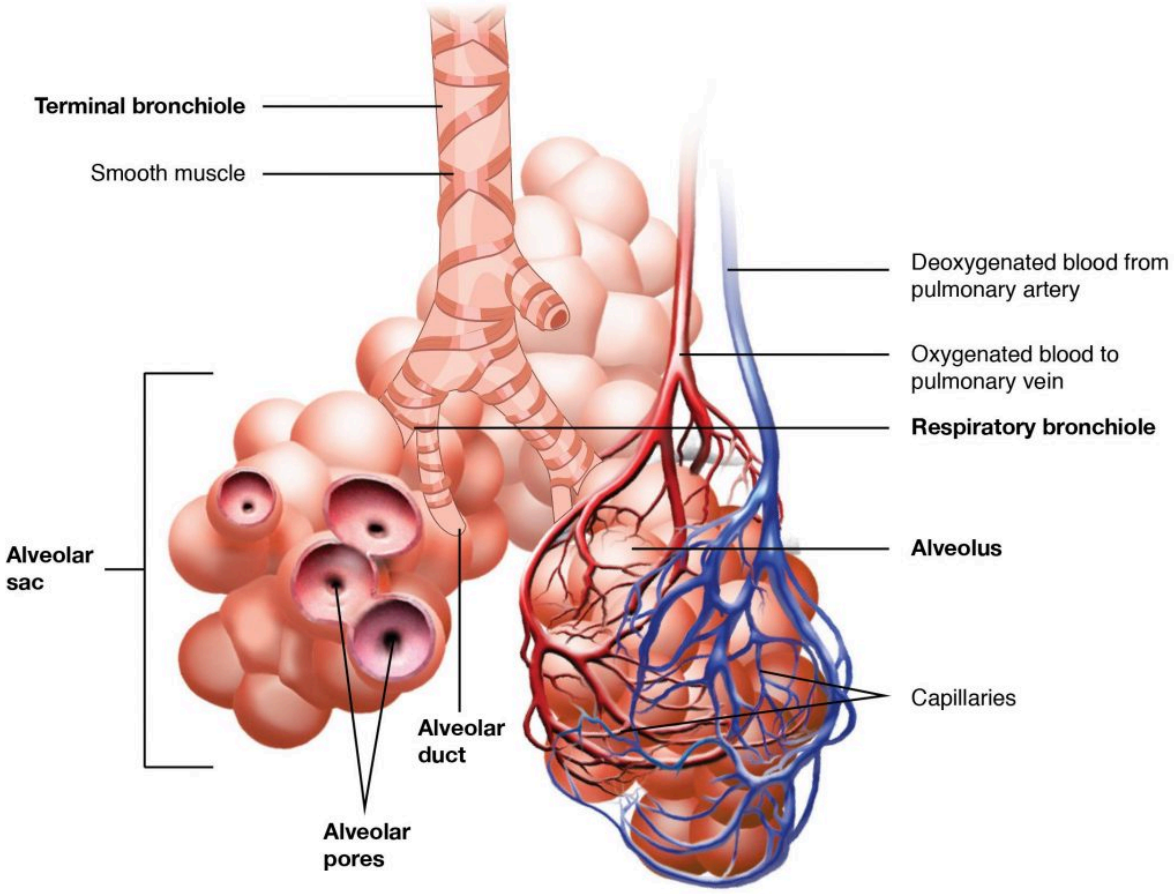


Figure 5.2 The Respiratory Zone. Bronchioles lead to alveolar sacs in the respiratory zone where gas exchange occurs

Alveoli

An alveolar duct is a tube composed of smooth muscle and connective tissue, which opens into a cluster

of alveoli. An alveolus is one of the many small, grape-like sacs that are attached to the alveolar ducts.

An alveolar sac is a cluster of many individual alveoli that are responsible for gas exchange. See Figure 5.3
"2310 Structures of the Respiratory Zone.jpg" by OpenStax College is licensed under CC BY 3.0 Access for free at https://openstax.org/books/anatomy-and-physiology/pages/22-1-organs-and-structures-of-the-respiratory-system
for an illustration of the structures of the respiratory zone.

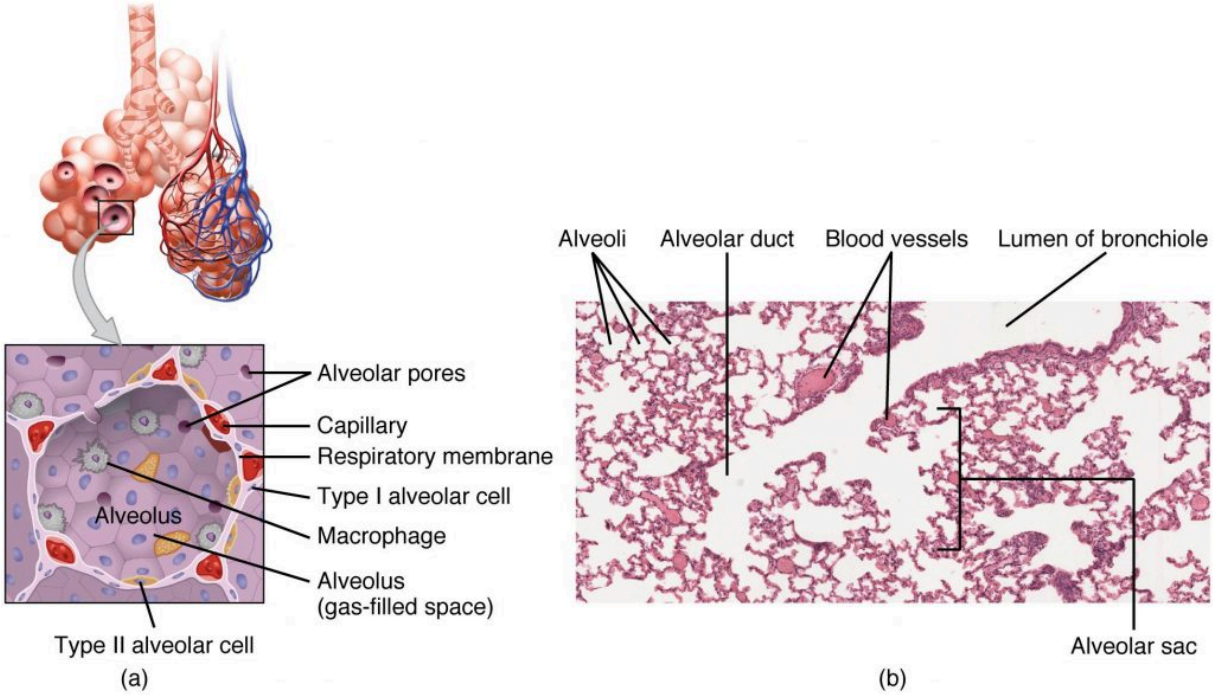


Figure 5.3 Structures of the Respiratory Zone. The alveolus is responsible for gas exchange

Respiratory Rate and Control of Ventilation

Breathing usually occurs without thought, although at times you can consciously control it, such as when you swim under water, sing a song, or blow bubbles. The **respiratory rate** is the total number of breaths, or respiratory cycles, that occur each minute. Respiratory rate can be an important indicator of disease, as the rate may increase or decrease during an illness. The respiratory rate is controlled by the respiratory center located within the medulla oblongata in the brain, which responds primarily to changes in carbon dioxide, oxygen, and pH levels in the blood.

The normal respiratory rate of a child decreases from birth to adolescence. A child under 1 year of age has a normal respiratory rate between 30 and 60 breaths per minute, but by the time a child is about 10 years old, the normal rate is closer to 18 to 30. By adolescence, the normal respiratory rate is similar to that of adults, 12 to 18 breaths per minute.

Neurons that stimulate the muscles of the respiratory system are responsible for controlling and regulating pulmonary ventilation. The major brain centers involved in pulmonary ventilation are the medulla oblongata and the pontine respiratory group. (See Figure 5.4
"2327 Respiratory Centers of the Brain.jpg" by OpenStax College is licensed under CC BY 3.0 .Access for free at https://openstax.org/books/anatomy-and-physiology/pages/22-3-the-process-of-breathing
for an illustration of the respiratory centers of the brain.)

Medulla

Pons

Ventral respiratory

Figure 5.4 Respiratory Centers of the Brain

Supplementary Videos: See the supplementary videos below related to respiratory anatomy and physiology.

Anatomy of Respiratory System

Forciea, B. (2015, May 13). Repiratory System Anatomy (v2.0). [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/aqTwrdMS6CE

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1562#oembed-1

Inhalation and Exhalation

Forciea, B. (2015, May 12). Anatomy and Physiology: Respriratory System: Breathing Mechanics (v2.0). [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/X-J5Xgg3l6s

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1562#oembed-2

Carbon Dioxide Transport

Forciea, B. (2015, May 12). Repiratory System: C02 Transport (v2.0). [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/BmrvqZoxHYI

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1562#oembed-3

Surface Tension

Forciea, B. (2015, May 13). Anatomy and Physiology: Respiratory System: Surface Tension (v2.0). [Video]. YouTube. All rights reserved. Video used with permission. https://youtu.be/YHTAausYA94

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1562#oembed-4

5.3 Diseases of the Respiratory System

Open Resources for Nursing (Open RN)

Allergies

Allergies occur when your immune system reacts to a foreign substance – such as pollen, bee venom, pet dander, or food – that doesn't cause a reaction in most people.

Your immune system produces substances known as antibodies. When you have allergies, your immune system makes antibodies that identify a particular allergen as harmful, even though it isn't. When you come into contact with the allergen, your immune system's reaction can inflame your skin, sinuses, airways, or digestive system.

The severity of allergies varies from person to person and can range from minor irritation to a potentially life-threatening emergency. While most allergies can't be cured, treatments can help relieve allergy symptoms.

Allergy symptoms, which depend on the substance involved, can affect airways, sinuses, and nasal passages, skin, and the digestive system.
Mayo Clinic Staff. (2018, January 6). *Allergies.* https://www.mayoclinic.org/diseases-conditions/allergies/symptoms-causes/syc-20351497

Hay fever, also called allergic rhinitis, can cause:

- Sneezing
- Itching of the nose, eyes, or roof of the mouth
- Runny, stuffy nose
- Watery, red or swollen eyes (conjunctivitis)

A food allergy can cause:

- Tingling in the mouth
- Swelling of the lips, tongue, face, or throat
- Hives
- Anaphylaxis

An insect sting allergy can cause:

- Large area of swelling (edema) at the sting site
- Itching or hives all over the body
- Cough, chest tightness, wheezing, or shortness of breath
- Anaphylaxis

A drug allergy can cause:

- Hives
- Itchy skin
- Rash
- Facial swelling
- Wheezing
- Anaphylaxis

Atopic dermatitis, an allergic skin condition also called eczema, can cause skin to:

- Itch
- Redden
- Flake or peel

Anaphylaxis

Some types of allergies, including allergies to foods and insect stings, can trigger a severe reaction known as **anaphylaxis.** As a life-threatening medical emergency, anaphylaxis can cause a patient to go into shock. Signs and symptoms of anaphylaxis include:

- Loss of consciousness
- Drop in blood pressure
- Severe shortness of breath
- Skin rash
- Lightheadedness
- Rapid, weak pulse
- Nausea and vomiting

Asthma

Asthma is a common condition that affects the lungs in both adults and children. Approximately 8.2 percent of adults (18.7 million) and 9.4 percent of children (7 million) in the United States suffer from asthma. In addition, asthma is the most frequent cause of hospitalization in children.

Asthma is a chronic disease characterized by inflammation, edema, and bronchospasm of the airways, which inhibits air from entering the lungs. In addition, excessive mucus secretion can occur, which further contributes to airway blockage. Cells of the immune system, such as eosinophils and mononuclear cells, may also be involved in infiltrating the walls of the bronchi and bronchioles.

Bronchospasms occur periodically and lead to an “asthma attack.” An attack may be triggered by environmental factors such as dust, pollen, pet hair, or dander; changes in the weather; mold; tobacco smoke; respiratory infections; exercise; and stress.

See Figure 5.5

for an illustration of how asthma affects the airways.

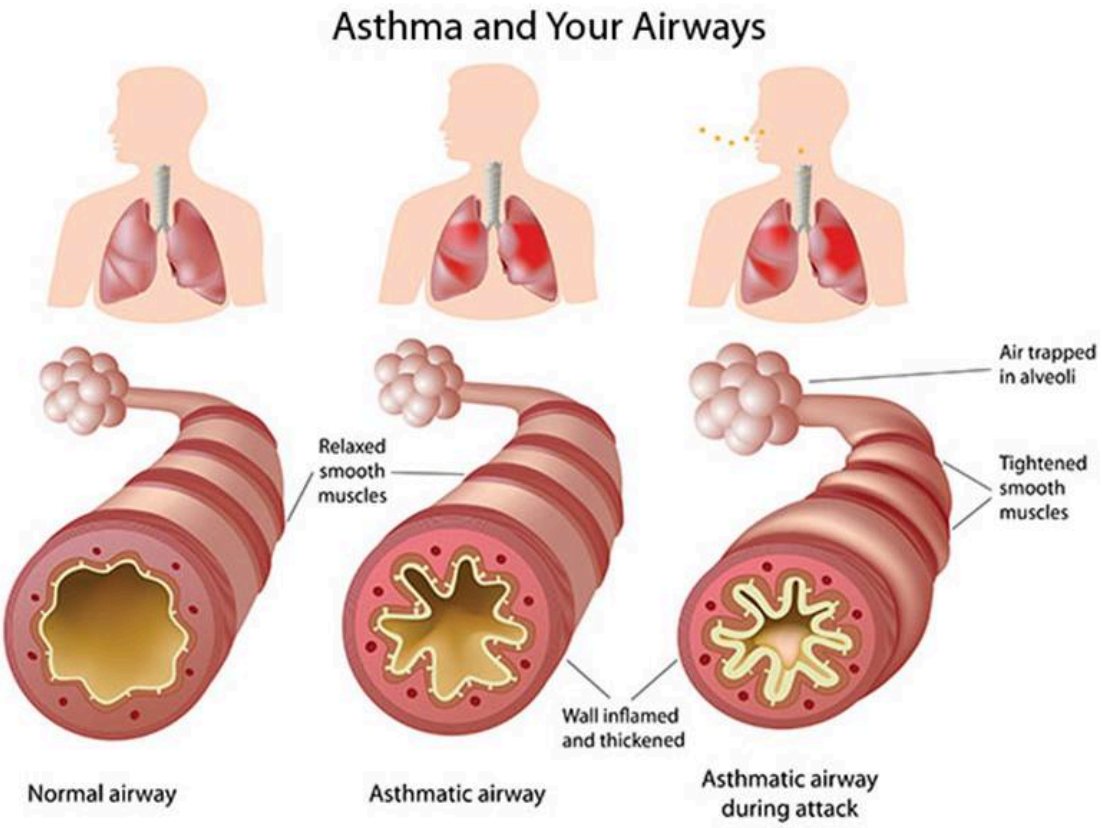


Figure 5.5 How Asthma Affects the Airways

Symptoms of an asthma attack involve coughing, shortness of breath, wheezing, and tightness of the chest. Symptoms of a severe asthma attack that requiring immediate medical attention include difficulty breathing that results in **cyanotic** lips or face, confusion, drowsiness, a rapid pulse, sweating, and severe anxiety.

The severity of the condition, frequency of attacks, and identified triggers influence the type of medication that an individual may require. Long-term treatments are used for patients with severe asthma. Short-term, fast-acting drugs are used to treat an asthma attack and are typically administered via an inhaler or nebulizer.

View the following video for additional insight into how asthma works.

How Does Asthma Work?

TED-Ed. (2017, May 11). How does asthma work? - Christopher E. Gaw. [Video]. YouTube. https://youtu.be/PzfLDi-sL3w

One or more interactive elements has been excluded from this version of the text. You can view them online here: https://wtcs.pressbooks.pub/pharmacology/?p=1571#oembed-1

Bronchitis

Bronchitis is an inflammation of the lining of the bronchial tubes, which carry air to and from the lungs. People who have bronchitis often cough up thickened mucus, which can be discolored. Bronchitis may be either acute or chronic.

Often developing from a cold or other respiratory infection, acute bronchitis is very common. Acute bronchitis, also called a chest cold, usually improves within a week to 10 days without lasting effects, although the cough may linger for weeks.

Chronic bronchitis, a more serious condition, is a constant irritation or inflammation of the lining of the bronchial tubes, often due to smoking. Chronic bronchitis is one of the conditions included in COPD.
Mayo Clinic Staff. (2017, April 11). *Bronchitis.* https://www.mayoclinic.org/diseases-conditions/bronchitis/symptoms-causes/syc-20355566.

Symptoms for either acute bronchitis or chronic bronchitis may include:

- Cough
- Production of mucus (sputum), which can be clear, white, yellowish-gray, or green in color — rarely, it may be streaked with blood
- Fatigue
- Shortness of breath
- Slight fever and chills
- Chest discomfort

Cold

The common cold is a viral infection of the upper respiratory tract. Many types of viruses can cause a common cold. Children younger than 6 are at greatest risk of colds, but healthy adults can also expect to have two or three colds annually. Most people recover from a common cold in a week or 10 days. Symptoms might last longer in people who smoke.

Symptoms of a common cold usually appear one to three days after exposure to a cold-causing virus. Signs and symptoms, which can vary from person to person, might include:

- Runny or stuffy nose
- Sore throat
- Cough
- Congestion
- Slight body aches or a mild headache
- Sneezing
- Low-grade fever
- Generally feeling unwell (malaise)
  Mayo Clinic Staff. (2019, April 20). *Common cold.* https://www.mayoclinic.org/diseases-conditions/common-cold/symptoms-causes/syc-20351605

Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) is a chronic inflammatory lung disease that causes

obstructed airflow out of the lungs. Symptoms include breathing difficulty, cough, mucus (sputum) production, and wheezing. It is often caused by long-term exposure to irritating gases or dust, and most often occurs due to smoking. People with COPD are at increased risk of developing heart disease, lung cancer, and a variety of other conditions.

Emphysema and chronic bronchitis are the two types of COPD. Emphysema is a condition in which the alveoli at the end of the smallest air passages (bronchioles) of the lungs are destroyed and hyperinflated. Chronic bronchitis is inflammation of the lining of the bronchial tubes, characterized by daily cough and mucus (sputum) production. See Figure 5.6 for an illustration of normal lungs compared to lungs with COPD.

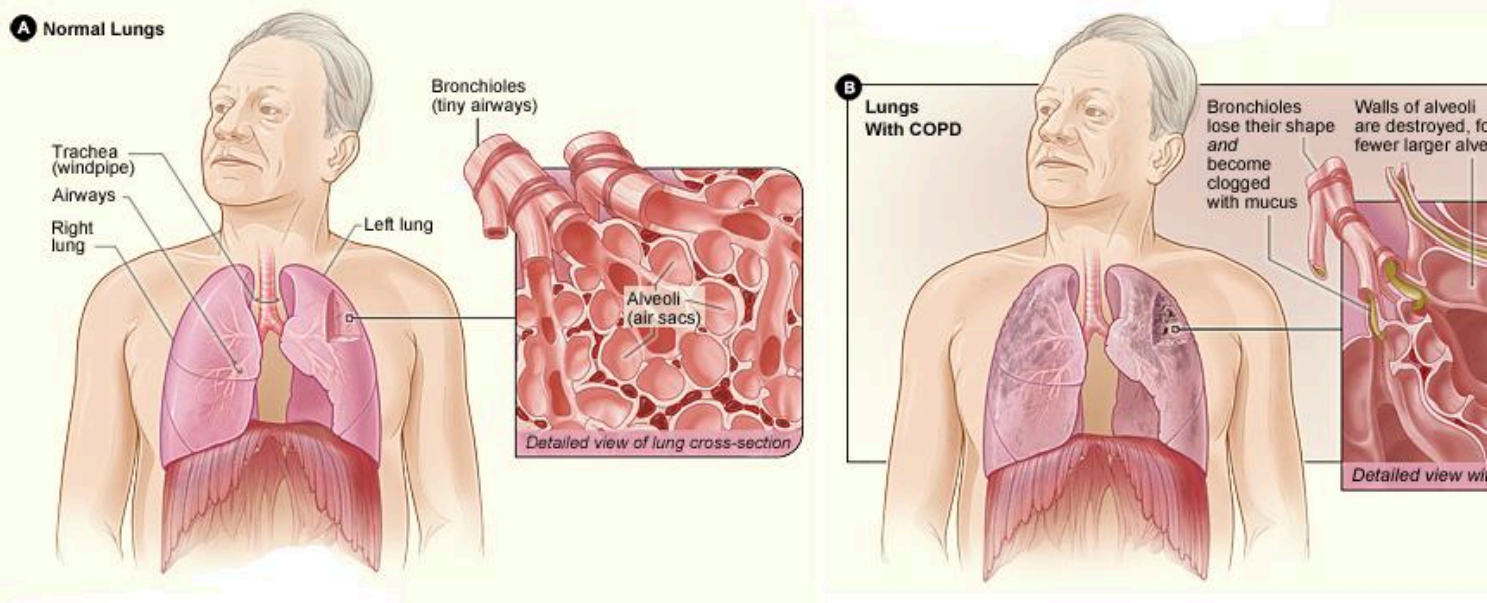


Figure 5.6 Normal lungs compared with lungs in a person with COPD

COPD is treatable but not curable. COPD symptoms often don't appear until significant lung damage has occurred, and they usually worsen over time, particularly if smoke exposure continues.

Other signs and symptoms of COPD may include:

- Shortness of breath, especially during physical activities
- Wheezing
- Chest tightness
- Chronic cough that may produce mucus (sputum) that may be clear, white, yellow, or greenish
- Cyanosis
- Frequent respiratory infections
- Lack of energy
- Unintended weight loss (in later stages)

Unlike some diseases, COPD has a clear cause and a clear path of prevention. The majority of cases are directly related to cigarette smoking, and the best way to prevent COPD is to never smoke — or to teach patients to stop smoking now.

Mayo Clinic Staff. (2017, August 11). *COPD*. https://www.mayoclinic.org/diseases-conditions/copd/symptoms-causes/syc-20353679

Interactive Activity

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://wtcs.pressbooks.pub/pharmacology/?p=1571#h5p-21

Everyday Connection

The Effects of Second-Hand Tobacco Smoke

The burning of a tobacco cigarette creates multiple chemical compounds that are released through mainstream smoke, which is inhaled by the smoker, and through sidestream smoke, which is the smoke that is given off by the burning cigarette. Second-hand smoke, which is a combination of sidestream smoke and the mainstream smoke that is exhaled by the smoker, has been demonstrated by numerous scientific studies to cause disease. At least 40 chemicals in sidestream smoke have been identified that negatively impact human health, leading to the development of cancer or other conditions, such as immune system dysfunction, liver toxicity, cardiac arrhythmias, pulmonary edema, and neurological dysfunction. Furthermore, second-hand smoke has been found to harbor at least 250 compounds that are known to be toxic, carcinogenic, or both. Some major classes of carcinogens in second-hand smoke are polyaromatic hydrocarbons (PAHs), N-nitrosamines, aromatic amines, formaldehyde, and acetaldehyde.

Tobacco and second-hand smoke are considered to be carcinogenic. Exposure to second-hand smoke can cause lung cancer in individuals who are not tobacco users themselves. It is estimated that the risk of developing lung cancer is increased by up to 30 percent in nonsmokers who live with an individual who smokes in the house, as compared to nonsmokers who are not regularly exposed to second-hand smoke. Children are especially affected by second-hand smoke. Children who live with an individual who smokes inside the home have a larger number of lower respiratory infections, which are associated with hospitalizations, and higher risk of sudden infant death syndrome (SIDS). Second-hand smoke in the home has also been linked to a greater number of ear infections in children, as well as worsening symptoms of asthma.

5.4 Nursing Process Considerations

Open Resources for Nursing (Open RN)

Nursing Process Related to Respiratory Medications

Now that we have reviewed the respiratory system and common respiratory disorders, let's apply the nursing process to the administration of respiratory medications.

Nursing Process: Assessment

Although there are numerous details to consider when administering medications, it is always important to first think about what you are giving and why?

First, let's think of why?

Respiratory medications are often given to alleviate allergies, cold symptoms, or to decrease/eliminate shortness of breath (SOB). An important piece of your nursing assessment should be to assess the patient's respiratory status. The respiratory assessment includes observing the respiratory rate and quality of respirations (shallow, deep), obtaining a pulse oximetry reading, and auscultating lung sounds. Other pieces of the assessment include inspecting skin color, such as observing for **pallor**, or cyanosis, and determining if there is a cough or **sputum** present. If sputum is present, it should be assessed for color, odor, consistency, and amount (COCA).

Additional baseline information to collect prior to the administration of any respiratory medication includes any history of allergy or previous adverse drug response.

Nursing Process: Implementation of Interventions

Respiratory medications are available in many different formulations, such as nasal spray, inhalations, oral tablets or liquids, injections, or intravenous route, so it is always important to verify the correct route and anticipate the associated side effects. For example, inhalations deliver the required medicine or medicines directly to the lungs, which means the medicine(s) can act directly on the lung tissues, minimizing systemic side effects. On the other hand, intravenous medications are administered to act quickly, but can cause systemic side effects. Additionally, some products contain more than one medicine with different dosages (for example, inhalers that combine a long-acting bronchodilator with a glucocorticoid).

During the administration of respiratory medications, it is important to anticipate the expected outcome of the medication and any common side effects. For example, albuterol is a short acting Beta-2 agonist that is given for bronchodilation. The nurse should plan to perform a respiratory assessment before and after administration of albuterol to document the effectiveness of the medication, as well as monitor for tachycardia, a common side effect.

Additionally, the nurse should also ensure the proper use of the inhalers by the patient. Observe the patient self-administering the medication, and further instruct the patient in proper use.
Drugs.com. (n.d.). *Respiratory agents.* https://www.drugs.com/drug-class/respiratory-agents.html

Nursing Process: Evaluation

Finally, it is important to always evaluate the patient's response to a medication. With respiratory medications, the nurse should assess decrease in allergy symptoms (cough, runny nose, tearing eyes) and any decrease in shortness of breath. The nurse should complete a respiratory assessment (respirations, pulse oximetry, and lung auscultation) before and after the medications have been administered and compare the results. If the symptoms are not improving or the clinical assessment is worsening, prompt intervention is required (such as notification of the health care provider for further orders) to prevent further clinical deterioration.

5.5 Respiratory Medication Classes

Open Resources for Nursing (Open RN)

Now that we have reviewed basic concepts, we will take a closer look at specific respiratory classes and specific administration considerations, therapeutic effects, adverse/side effects, and teaching needed for

each class of medications.

5.6 Antihistamines

Open Resources for Nursing (Open RN)

Diphenhydramine is an example of a first-generation antihistamine. (See Figures 5.7

and 5.8.

) Second-generation antihistamines were developed to have fewer side effects. An example of a second-generation antihistamine is cetirizine.

Figure 5.7 Diphenhydramine is a first generation antihistamine that is available orally or as an IV medication

5.8 Diphenhydramine HCl preparation, single dose vial for IV administration

Mechanism of Action

Antihistamines have the following mechanisms of action: blocks histamine at H1 receptors; inhibits smooth muscle constriction in blood vessels and the respiratory and GI tracts; and decreases capillary permeability, salivation, and tear formation.

Indications for Use

Antihistamines are used for relief of allergy or cold symptoms.

Nursing Considerations Across the Lifespan

This medication is not safe for children under the age of 2 years without a healthcare provider's order.

Adverse/Side Effects

First-generation medications can cause anticholinergic effects (such as dry mouth, urinary retention, constipation and blurred vision). CNS depression or CNS stimulation with excessive doses can occur, especially in children. Therefore, first-generation antihistamines should be used with caution in the elderly.

Second-generation medications may cause headache, nausea, vomiting, dysmenorrhea, and fatigue.
Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Patient Teaching & Education

Patients should be advised that antihistamines may cause drowsiness, and concurrent use of alcohol or other CNS depressants should be avoided. Patients should take only the recommended amount of

medication and not to exceed dosing recommendations. Some patients may experience side effects such as dry mouth, and frequent oral hygiene may assist in alleviating discomfort.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for diphenhydramine and cetirizine in Table 5.6.

Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Medication grids are intended to assist students to learn key points about each medication class. Basic information related to a common generic medication in this class is outlined, including administration considerations, therapeutic effects, and side effects/adverse effects. Prototype/generic medication listed in the medication grid is also hyperlinked to a free resource from the U.S. National Library of Medicine called Daily Med. Because information about medication is constantly changing, nurses should always consult evidence-based resources to review current recommendations before administering specific medication.

Table 5.6 Diphenhydramine and Cetirizine Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Adverse/Side Effects
First-generation antihistamine	diphenhydramine	Take as directed Avoid allergens Avoid alcohol or CNS depressants due to sedation	Temporarily relieves symptoms due to hay fever or other upper respiratory allergies: runny nose; sneezing; itchy, watery eyes; itching of the nose or throat Temporarily relieves symptoms due to the common cold such as runny nose and sneezing	Sedation Anticholinergic effects Gastrointestinal: Nausea/ Vomiting Paradoxical effect: excitation in children
Second-generation antihistamine	cetirizine	Take as directed Avoid allergens Avoid alcohol or CNS depressants due to sedation	Temporarily relieves symptoms due to hay fever or other upper respiratory allergies: runny nose; sneezing; itchy, watery eyes; itching of the nose or throat	Non-sedating Anticholinergic effects Gastrointestinal: Nausea/ vomitting Paradoxical effect: excitation

in children

5.7 Decongestants

Open Resources for Nursing (Open RN)

Pseudoephedrine is an over-the-counter (OTC) decongestant (see Figure 5.9

). More details regarding pseudoephedrine are described in the “Autonomic Nervous System” chapter.

Figure 5.9 Pseudoephedrine (Sudafed) is a decongestant that is available OTC

Mechanism of Action

Pseudoephedrine acts directly on the adrenergic receptors and acts indirectly by releasing norepinephrine from its storage sites. The drug produces vasoconstriction, which shrinks nasal mucosa membranes.

Indications for Use

Decongestants relieve nasal obstruction due to inflammation.

Nursing Considerations Across the Lifespan

This medication is not safe for children under the age of 4 years.

Adverse/Side Effects

Common adverse/side effects include hypertension, dysrhythmia, dizziness, headache, insomnia, and restlessness. Some patients may experience blurred vision, tinnitus, chest tightness, dry nose, and nasal congestion.

Decongestants are contraindicated in patients with severe hypertension, coronary artery disease (CAD), narrow-angle glaucoma, and some antidepressant use. Also, use with caution in patients who have cardiac dysrhythmias, hyperthyroidism, DM (diabetes mellitus), prostatic hypertrophy, and glaucoma.
Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Patient Teaching & Education

Patients must take care to follow dosing recommendations. If dosing standards are surpassed, some patients may experience side effects such as increased nervousness, breathing difficulties, heart rate changes, and hallucinations.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on Pseudoephedrine in Table 5.7.

Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Table 5.7 Pseudoephedrine Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Adverse/Side Effects
Decongestant	pseudoephedrine	Administration (drops, sprays) Avoid prolonged use > 7 days Use cautiously with cardiovascular disease Maintain hydration (2-3 liters/day)	Temporarily relieves nasal congestion due to the common cold, hay fever, or other upper respiratory allergies Temporarily relieves sinus congestion and pressure	Cardiovascular stimulation Rebound congestion with nasal route

5.8 Antitussives

Open Resources for Nursing (Open RN)

Dextromethorphan is an example of an antitussive (see Figure 5.10

).

Figure 5.10 Robitussin DM is an OTC medication that contains dextromethorphan and guaifenesin

Mechanism of Action

Dextromethorphan suppresses a cough by depressing the cough center in the medulla oblongata or the cough receptors in the throat, trachea, or lungs, effectively elevating the threshold for coughing.

Indication for Use

Antitussives are used for a dry, hacking, nonproductive cough that interferes with rest and sleep.

Nursing Considerations Across the Lifespan

This medication is not safe for children under the age of 4 years.

Adverse/Side Effects

The most common side effects include nausea and drowsiness. Some patients may experience a rash or difficulty breathing. High doses may cause hallucinations and disassociation, and the drug has been reported to be used as a recreational drug.
Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Patient Teaching & Education: Patients should take care to avoid irritants that stimulate their cough. Additionally, antitussive medications can cause drowsiness, and patients should avoid taking them with other CNS depressants or alcohol.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid on dextromethorphan in Table 5.8.

,

Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

,

Table 5.8 Dextromethorphan Medication Grid

Class/Subclass	Prototype/Generic	Administration Considerations	Therapeutic Effects	Adverse/Side Effects
Antitussive	dextromethorphan	Take as directed Administer undiluted No alcohol due to CNS depression Use with caution in patients with respiratory disease and with those taking monoamine oxidase inhibitors (MAOIs)	Temporarily relieves coughing due to minor throat and bronchial irritation as may occur with the common cold	CNS: sedation and dizziness Mild gastrointestinal effects

5.9 Expectorants

Open Resources for Nursing (Open RN)

Guaifenesin is an example of an expectorant.

Mechanism of Action

Expectorants reduce the viscosity of tenacious secretions by irritating the gastric vagal receptors that stimulate respiratory tract fluid, thus increasing the volume but decreasing the viscosity of respiratory tract secretions.

Indication for Use

Expectorants are used for a productive cough and for loosening mucus from the respiratory tract.

Nursing Considerations Across the Lifespan

The medication is safe for all ages. Guaifenesin is only recommended for use during pregnancy and breastfeeding when benefit outweighs the risk.

Adverse/Side Effects

Guaifenesin may cause a skin rash, headache, nausea, and vomiting.
Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Patient Teaching & Education

Patients should take care to avoid irritants that stimulate their cough. Additionally, the medication can cause drowsiness. Patients should avoid taking them with other CNS depressants or alcohol.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for guaifenesin in Table 5.9.

Table 5.9 Guaifenesin Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Adverse/Side Effects
Expectorant	guaifenesin	No eating or drinking for 30 minutes after syrup Encourage patient to cough and deep breath Stay hydrated (2-3 liters/day)	Helps loosen sputum (mucus) and thin bronchial secretions to make coughs more productive	Increased drowsiness in large doses Gastrointestinal: Nausea, vomiting, diarrhea

5.10 Beta-2 Agonist

Open Resources for Nursing (Open RN)

Albuterol is an example of a short-acting Beta-2 agonist. See Figures 5.11

and 5.12

for images of an albuterol inhaler and nebulizer.

Salmeterol is an example of a long-acting Beta-2 agonist.

See the “Autonomic Nervous System” chapter for more information regarding Beta-2 agonists.

Figure 5.11 An albuterol inhaler

Figure 5.12 A vial of albuterol sulfate for inhalation

Mechanism of Action

Albuterol and salmeterol stimulate Beta 2-adrenergic receptors in the smooth muscle of bronchi and bronchioles producing bronchodilation. Beta-1 receptors can also be inadvertently stimulated, causing tachycardia.

Indications for Use

Short-acting albuterol is used to prevent or treat bronchospasms in people with asthma, reversible obstructive airway disease, or exercise-induced bronchospasm. Long-acting salmeterol is used to prevent bronchospasm.

Adverse/Side Effects

Beta-2 agonists can cause muscle tremor, excessive cardiac stimulation, and CNS stimulation. Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Patient Teaching & Education

Patients should be instructed to take medication as directed and report any sustained or worsening symptoms to their healthcare provider. When first using an inhaler, patients should be instructed to prime the inhaler unit prior to administering their medication. Use of medications like albuterol can cause an unusual taste in the mouth and rinsing the mouth with water after use is permitted. Patients should have an understanding of medication onset and use short-acting and long-acting inhalers appropriately.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for albuterol and salmeterol in Table 5.10.

,

Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

,

This work is a derivative of Daily Med by U.S. National Library of Medicine in the public domain.

,

Adams, M., Holland, N., & Urban, C. (2020). *Pharmacology for nurses: A pathophysiologic approach* (6th ed.). pp. 622-63 & 626. Pearson.

Table 5.10 Albuterol and Salmeterol Medication Grid

Class/ Subclass	Prototype/ Generic	Administration Consideration	Therapeutic Effects	Adverse/Side Effects
Short-acting Beta-2 agonist (SABA)	albuterol	Fast onset of action	Rapid bronchodilation	CNS stimulation (excitability) Cardiovascular stimulation (tachycardia)
Long-acting Beta-2 agonist (LABA)	salmeterol	Has a slow onset of action and will not abort an acute bronchospasm Increased risk of death with use during an "asthma attack" due to slow onset of action	Prevention of bronchospasm	Tachycardia, dysrhythmias, hypokalemia, hyperglycemia, paradoxical bronchoconstriction, and increased risk for asthma- related death

5.11 Anticholinergics

Open Resources for Nursing (Open RN)

Ipratropium is an example of a short-acting anticholinergic. Tiotropium is an example of a long-acting anticholinergic. Additional information regarding anticholinergics can be found in the "Autonomic Nervous System" chapter. (See Figure 5.13
"Spiriva HandiHaler"-brand dry powder inhaler (open).png" by RonEJ at English Wikipedia is licensed under CC0 1.0
for an image of tiotropium.)

Figure 5.13 Tiotropium, a long-acting anticholinergic

Mechanism of Action

Anticholinergics block the action of acetylcholine in bronchial smooth muscle, which reduces bronchoconstrictive substance release.

Indications for Use

Anticholinergics are used for maintenance therapy of bronchoconstriction associated with asthma, chronic bronchitis, and emphysema.

Adverse/Side Effects

Anticholinergics should be used with caution with the elderly and can cause cough, drying of the nasal mucosa, nervousness, nausea, GI upset, headaches, and dizziness.
Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

Patient Teaching & Education

Patients should be instructed to use the inhaler as directed and be careful not to exceed dosage recommendations. They should receive education regarding the onset of medication and differences in

usage for short- and long-acting anticholinergics. Some long-acting anticholinergics may cause signs of angioedema and the healthcare provider should be notified if this occurs.
uCentral from Unbound Medicine. https://www.unboundmedicine.com/ucentral

Now let's take a closer look at the medication grid for ipratropium and tiotropium in Table 5.11.

,

Frandsen, G. & Pennington, S. (2018). *Abrams' clinical drug: Rationales for nursing practice* (11th ed.). Wolters Kluwer.

,

,

Adams, M., Holland, N., & Urban, C. (2020). *Pharmacology for nurses: A pathophysiologic approach* (6th ed.). pp. 622-63 & 626. Pearson.

Table 5.11 Ipratropium and Tiotropium Medication Grid

Class/Subclass	Prototype/ Generic	Administration Considerations	Therapeutic Effects	Adverse/Side Effects
Anticholinergics (short acting)	ipratropium	Long-term management of pulmonary disease Slower onset of action	Rapid bronchodilation	Cough and drying of the nasal mucosa
Anticholinergics (long acting)	tiotropium	Long-term management of pulmonary disease Slower onset of action	Prevention of bronchospasm and reduces exacerbations in COPD patients	Cough and drying of the nasal mucosa

5.12 Corticosteriods

Open Resources for Nursing (Open RN)

Corticosteroids can be prescribed in a variety of routes. Fluticasone is an example of a commonly used inhaled corticosteroid; prednisone is an example of a commonly used oral corticosteroid; and methylprednisolone is a commonly used IV corticosteroid. Additional information about corticosteroids and potential adrenal effects is located in the "Endocrine" chapter.

Mechanism of Action

Fluticasone is a locally acting anti-inflammatory and immune modifier. The nasal spray is used for