LESSON ASSIGNMENT

LESSON 6  Drugs Used to Prevent and Treat Infection II

LESSON ASSIGNMENT  Paragraphs 6-1 through 6-38

LESSON OBJECTIVE

Upon completion of this lesson, you should be able to discuss actions, uses, untoward effects, administration, cautions, and contraindications of common aminoglycosides, sulfonamides, antifungals, anti-malarials, and anthelmintics, as well as metronidazole and gamma benzene hexachloride.

SUGGESTION

After studying the assignment, complete the exercises at the end of this lesson. These exercises will help you to achieve the lesson objectives.
LESSON 6
DRUGS USED TO PREVENT AND TREAT INFECTION II

Section I. AMINOGLYCOSIDES

6-1. INTRODUCTION

The aminoglycosides, a group of antibiotics including streptomycin, neomycin, gentamicin, and kanamycin, are similar in mode of antimicrobial action, toxic effects, pharmacology, and chemistry.

6-2. STREPTOMYCIN SULFATE

a. Indications. Streptomycin is a narrow-spectrum antibiotic used for the following organisms:

(1) Mycobacterium tuberculosis.

(2) Yersinis pestis (bubonic plague).

(3) Francisella tularensis (tularemia).

(4) Other organisms of known sensitivity.

b. Usual Dosage.

(1) For tuberculosis--1 gram, given once daily, usually in combination with other drugs.

(2) For tularemia--1 to 2 grams daily in divided doses for 7 to 10 days.

(3) For plague--2 to 4 grams daily in divided doses.

(4) For severe fulminating infections caused by known sensitive organisms, usually in combination with other antibiotics.

(a) Adult--2 to 4 grams daily, given in divided doses every 6 to 12 hours.

(b) Child--20 to 40 mg/kg of body weight, in divided doses every 6 to 12 hours.

NOTE: This drug is given intramuscularly only.
c. **Cautions and Warnings.**

(1) This drug should be used cautiously in pregnant women because of the fact that it can cross the placenta and cause ototoxicity (see d (1) below) in the fetus.

(2) Baseline audiometric tests should be run initially prior to therapy and then frequently during therapy to guard against ototoxicity.

d. **Adverse Reactions.**

(1) **Ototoxicity.** Ototoxicity is toxicity to the eighth nerve possibly resulting in damage to hearing and the sense of balance. Initial signs may include vestibular damage causing nausea, vomiting, and vertigo. Other symptoms include tinnitus, roaring noises, or a sense of fullness in the ears. Hearing loss, often permanent, may develop. The frequency and severity of ototoxicity are proportionate to the age of the client, the dosage level, and the duration of administration.

(2) **Other Reactions.** Other common adverse reactions include parathesia (abnormal sensation) of the face, rash, fever, urticaria, angio-neurotic edema, and eosinophilia. Allergic reactions occur most frequently with prolonged contact, either in clients with a long course of therapy or in medical personnel administering the drug; personnel preparing streptomycin solutions should wear gloves.

(3) **Superinfection.** Superinfection may occur.

e. **Supply.** Streptomycin sulfate is supplied in 1-gram quantities of powder, which must be reconstituted before injection. Streptomycin sulfate injection, 0.4 gram/ml, is supplied in 2.5-ml cartridge-needle units.

6-3. **KANAMYCIN SULFATE INJECTION**

a. **Indications.** Kanamycin (Kantrex) is a broad-spectrum bactericidal antibiotic. Because of its potential for toxic side effects, its use is limited mainly to certain serious gram-negative infections. It should not be used when less toxic anti-infective agents are available. It is effective in the treatment of *E. coli*, *Proteus* species, *Enterobacter aerogenes*, *Klebsiella pneumoniae*, *Serratia marcescens*, and *Mima-Herrelea*. Although kanamycin is not the drug of choice for staphylococcal infections, it may be indicated under certain conditions for the treatment of known or suspected staphylococcal disease. These situations include:

(1) The initial therapy of severe infections where the organism is thought to be either a gram-negative bacterium or a staphylococcus.

(2) Infections due to susceptible strains of staphylococci in clients allergic to other less toxic antibiotics.
(3) Mixed staphylococcal and gram-negative infections.

b. Administration. The usual dose is 7.5 mg/kg of body weight, IM every 12 hours. The average daily adult dose is 1.0 gram.

   (1) Uncomplicated infections of sensitive organisms should respond in 24 to 48 hours. Should no improvement be seen in 3 to 5 days, therapy should be stopped and bacterial sensitivity rechecked.

   (2) Partially used vials should be discarded after 48 hours, and kanamycin should not be physically mixed with other anti-infective agents.

c. Cautions and Warnings.

   (1) Prior to and during therapy, audiograms should be obtained on clients with kidney dysfunction if therapy is to last more than 5 days.

   (2) Kanamycin therapy should be stopped if client complains of tinnitus or hearing loss.

   (3) Clients should be well hydrated to prevent chemical irritation to the renal tubules. Concurrent use of kanamycin and potent diuretics, such as furosemide and ethacrynic acid, should be avoided.

   (4) Concurrent administration of kanamycin and other potentially nephrotoxic and ototoxic drugs should be avoided.

   (5) Safety in pregnancy has not been established.

   (6) Renal function should be checked prior to and during therapy. If azotemia or oliguria occurs, therapy should be discontinued.

   (7) Bacterial or mycotic superinfections may occur with therapy.

   (8) Allow for complete recovery from anesthesia and muscle relaxants before intraperitoneal instillation to avoid neuromuscular paralysis with respiratory depression.

d. Adverse Reactions.

   (1) Pain or irritation may occur at the site of injection.

   (2) Eighth cranial nerve damage, affecting mainly hearing, may be irreversible. In some clients, this hearing loss may not be detected until after therapy has been discontinued. Nerve damage is more likely to occur in clients with renal impairment.
(3) Renal function impairment with nitrogen retention and proteinuria can occur during kanamycin therapy, especially in clients with pre-existing kidney damage.

(4) Neuromuscular paralysis with respiratory depression has been reported following parenteral or intraperitoneal administration.

e. Supply. Kanamycin sulfate injection, 37.5-mg/ml for pediatric use, is supplied in 2-ml units. The preparation for adult use, 333-mg/ml, is supplied in 3-ml units.

6-4. GENTAMICIN SULFATE

a. Gentamicin sulfate (Garamicin) has the same general uses and warnings as kanamycin (above). It is effective against most strains of staphylococci, E. coli, Klebsiella, Enterobacter, and Pseudomonas aeruginosa, and many strains of Proteus and Serratia.

b. The concomitant use of carbenicillin (a penicillin) with gentamicin may result in synergistic activity against some strains of Pseudomonas and may allow for lower doses of gentamicin to be used.

c. Gentamicin is not considered the drug of choice for treating gram-negative sepsis because of susceptible organisms.

d. It is available as gentamicin sulfate cream (1-mg of gentamicin per gram) and as gentamicin sulfate injection (40-mg/ml) in a 2-ml bottle for intramuscular use.

6-5. NEOMYCIN SULFATE

Neomycin is very similar to kanamycin, as discussed above, but it is usually restricted to topical applications and to oral use for reduction of microbes in the gut before surgery. It has a wide range of activity; it is effective against both gram-negative and gram-positive bacteria. It is useful in many local infections, including burns, wounds, ulcers, and other sites of infection. However, Pseudomonas species and streptococci tend to be resistant.

NOTE: Neomycin is often combined with the narrow-spectrum antibiotic bacitracin. Bacitracin (not an aminoglycoside) is especially effective against gram-positive organisms. It too is usually confined to topical use. It is often effective in the treatment of infections associated with wounds, carbuncles, superficial and deep abscesses, and infected ulcers. It is available alone in bacitracin ointment and bacitracin ophthalmic ointment.

a. Neomycin Sulfate. Neomycin sulfate is available alone in a powder and in 350-mg tablets.
b. **Bacitracin and Neomycin Sulfate Ointment.** Bacitracin and neomycin sulfate (Bacimycin) ointment contains 500-units of bacitracin and 3.5-mg of neomycin sulfate in each gram. This ointment must not be used in the eyes, deep or puncture wounds, or severe burns. Prolonged use may result in superinfection; if this occurs, use of the ointment should cease and other treatment used.

c. **Neomycin Sulfate and Dexamethasone Sodium Phosphate Ophthalmic Ointment.** This ophthalmic ointment (NeoDecadron) is included in a chemical agents casualty treatment set. An ophthalmic solution of the same drugs is also available. It is indicated for severe conditions such as corneal burns and ocular infections in which vision is threatened by acute, severe uveitis and stromal edema. (More extensive information should be consulted prior to its use.) Dexamethasone, a synthetic drug similar to hydrocortisone, is included for its anti-inflammatory and anti-allergic effects, but it may also reduce tissue resistance to infection. Neomycin generally helps to control infections which may result from suppression of the inflammatory response or which may be secondary to the original irritation.

d. **Neomycin Sulfate, Hydrocortisone, and Polymyxin B Sulfate Suspension.** These eardrops (Cortisporin Otic Drops) may be used to treat otitis external (inflammation of the external ear) caused by organisms susceptible to neomycin or polymyxin B (also an antibiotic). Hydrocortisone is included for its anti-inflammatory effects; however, it may also reduce tissue resistance to infection. An ophthalmic suspension of the same drugs is also available.

e. **Neomycin Sulfate, Gramicidin, and Polymyxin B Sulfate.** These three antibiotics are available both in a cream and in an ophthalmic solution.

**Section II. SULFONAMIDES**

6-6. **INTRODUCTION**

In the 1930's, chemists in Germany developed a substance, prontosil, which was effective against hemolytic streptococci. Later, researchers in France added hydrogen to a portion of the prontosil molecule and thus created the basic sulfonamide, which had a therapeutic efficacy no less than that of prontosil. These were the first chemical agents to be successfully employed systemically for the prevention and cure of bacterial infections. In the following years, many more alterations were made in the sulfonamide molecules, creating a large number of antibacterial drugs. Even with the advent of antibiotics, the sulfonamides are still drugs of choice for some types of infection. In fact, because of their low cost and their usefulness in some common infections, they are still among the most widely used antibacterial agents.
6-7. EFFECTIVENESS

a. The sulfonamides are bacteriostats. They stop bacterial growth by interfering with the production of folic acid in the bacteria cells. They do not interfere with human utilization of folic acid.

b. The ranges of effectiveness of the various sulfonamides are very similar to each other. However, some sulfonamides may be more potent against specific types of infection than others. The sulfonamides are effective against gram-positive and gram-negative bacteria, as well as several other types of microorganisms.

6-8. SULFISOXAZOLE

a. Indications. Sulfisoxazole (Gantrisin) is rapidly absorbed and rapidly excreted. It is useful in:

   (1) Acute, recurrent, or chronic urinary tract infections (primarily cystitis, pyelitis, pyelonephritis) because of susceptible organisms (usually *E. coli*, *Klebsiella-Aerobacter*, *Staphylococcus*, *Staphylococcus aureus*, *Proteus mirabilis*).

   (2) Meningococcal meningitis because of susceptible organisms.

   (3) *Haemophilus influenzae* meningitis when used with parenteral streptomycin; acute otitis media because of *H. influenzae* when used with adequate penicillin.

   (4) Trachoma.

   (5) Inclusion conjunctivitis.

   (6) Nocardiosis.

   (7) Chancroid.

b. Usual Dosage.

   (1) Child. The initial dose for children is one-half of the 24-hour dose. The maintenance dose is 150 mg/kg/24 hours or 4 grams/m² is 6 grams.

   NOTE: Systemic sulfonamides are contraindicated for infants under two months of age.

   (2) Adult. The initial adult dose is 2 to 4 grams. The maintenance dose is 4 to 8 grams daily, divided into 4 to 6 doses.
c. Cautions and Warnings.

(1) This product should be used very cautiously in pregnant women and nursing mothers, because this drug passes the placenta and is excreted in the milk and may cause kernicterus (condition of severe neural symptoms, with high blood levels of bilirubin).

(2) Adequate fluid intake must be maintained in order to prevent crystalluria (crystals in the urine) and stone formation.

(3) Sulfonamides should be given cautiously in clients with impaired renal or hepatic function and to those with severe allergy or bronchial asthma.

(4) Use this drug cautiously in clients with glucose-6-phosphate dehydrogenase (G6PD) deficiency.

(5) Complete blood counts should be done frequently to guard against severe blood dyscrasias.

d. Adverse Reactions.

(1) Allergic reactions including rashes, pruritis, and fever are the most common adverse effects.

(2) Nausea, vomiting, headache, lassitude, dizziness, mental depression, abdominal pain, arthralgia, leukopenia, and photosensitivity may occur.

(3) Less common reactions include crystalluria, hepatotoxicity, jaundice, and serious blood dyscrasias.

(4) Clients with G6PD deficiency may develop hemolytic anemia.

e. Supply. Sulfisoxazole tablets, 0.5 gram each, are available.

6-9. SODIUM SULFACETAMIDE

a. Indications. Sodium sulfacetamide (Sodium Sulamyd) is used topically:

(1) For the treatment of conjunctivitis, corneal ulcer, and other superficial ocular infections.

(2) As adjunctive treatment in systemic therapy of trachoma.
b. **Usual Dosage.**

(1) *Ophthalmic solution, 15 percent.* For conjunctivitis or corneal ulcer, instill one or two drops into the lower conjunctival sac every two or three hours during the day, but use less at night. For trachoma, use four drops every two hours with concomitant systemic therapy with sulfonamides or tetracycline.

(2) *Ophthalmic ointment, 30 percent.* Apply a small amount four times daily and at bedtime. The ointment may be used adjunctively with the solution. The ointment is not sterile.

c. **Cautions and Warnings.**

(1) Sulfacetamide is contraindicated in individuals who are hypersensitive to sulfonamide preparations.

(2) Solutions are incompatible with silver preparations.

(3) Ophthalmic ointments may retard corneal healing.

(4) Nonsusceptible organisms, including fungi, may proliferate with use of these preparations.

(5) Sulfonamides are inactivated by para-aminobenzoic acid present in purulent exudates.

(6) Use with caution in clients who are deficient in glucose-6-phosphate dehydrogenase.

(7) Keep in a cool place.

d. **Adverse Reactions.** Common side effects are fever, skin rashes, urticaria, photosensitivity, and conjunctivitis.

e. **Supply.** Sodium sulfacetamide is supplied as a 15 percent ophthalmic solution and as a 10 percent ophthalmic ointment. It is also available in combinations called sodium sulfacetamide, phenylephrine hydrochloride, and prednisolone acetate ophthalmic suspension and sodium sulfacetamide and prednisolone acetate ophthalmic suspension.
6-10. INTRODUCTION

A dermatophyte is a fungus parasite upon the skin. For convenience, fungal infections are classified as deep (systemic) mycoses and superficial mycoses (dermatophytoses; fungal infections of the skin, hair, or nails).

a. Superficial Mycoses. Superficial infections of the skin are often chronic and resistant to treatment, but the general health of the client is rarely affected. The drugs discussed in this section are useful only for superficial mycoses. The names of some common dermatophytoses are provided below with the affected area of the body indicated after the dash.

(1) Tinea axillaris—armpit.
(2) Tinea palmaris—palm of the hand.
(3) Tinea pedis (athlete's foot)—foot.
(4) Tinea corporis (ringworm)—nonhairy skin.
(5) Tinea capitis (ringworm)—scalp.
(6) Tinea cruris ("jock itch")—upper surface of the thighs.
(7) Tinea versicolor—brownish-red scaling patches on the neck, arms, and trunk.

b. Candidiasis. Candidiasis (moniliasis) is an infection caused by Candida (the pathogenic species in man is Candida albicans). This yeast-like fungus is normally present on the mucous membranes of the gastrointestinal, respiratory, and female genital tracts, but when the body defense mechanisms are weakened or when other microbes have been destroyed by antimicrobial therapy, Candida albicans can establish dominance in these and other areas. Candidiasis of the throat is called thrush.

c. Deep Mycoses. Deep mycoses are often accompanied by systemic involvement, can be fatal, and are exceedingly difficult to treat. Fortunately, they are not common.

6-11. GRISEOFULVIN TABLETS

a. Indications. Griseofulvin (Fulvicin U/F) tablets are indicated for the treatment of dermatophytosis, including ringworm.
b. **Usual Dosage.** The usual oral dose is 0.5- to 1.0-gram daily, given in a single dose or divided doses after meals. Administration after a fatty meal increases its absorption. Treatment must be continued 3 to 6 weeks for skin infections, and up to 6 months if hair or nails are involved.

c. **Adverse Reactions.** Griseofulvin is a relatively safe drug although some allergic type reactions (rashes, serum sickness) have been reported. Photosensitivity, headache, and mental and neurologic problems have been seen in some clients.

d. **Cautions and Warnings.**

   (1) Griseofulvin is ineffective in treating Candida, tinea versicolor, and bacterial infections. If a mixed infection is present, a second agent must also be employed.

   (2) This drug should not be used unless laboratory findings indicate a sensitive organism.

   (3) In severe cases, concomitant administration of a topical antifungal (tolnaftate) may be needed.

   (4) Griseofulvin may increase the rate of metabolism of oral anticoagulants.

   (5) Contraindicated in clients with acute porphyria or with a history of the disease.

e. **Supply.** The drug is available as 0.5-gram tablets, compressed from microsized powder to allow maximum absorption.

**6-12. TOLNAFTATE SOLUTION**

a. **Indications.** Tolnaftate (Tinactin) is a topical antifungal useful in athlete's foot, ringworm, and other fungal infections. However, if the scalp, nails, palms, or soles are infected, an oral preparation such as griseofulvin is indicated.

b. **Usual Dosage.**

   (1) One to 2 drops of solution are rubbed into the lesion twice a day for 2 to 3 weeks.

   (2) Tinea versicolor: Rub in sufficient amount of solution to cover the area, twice a day.
c. **Cautions and Warnings.**

(1) A diagnosis of a fungal infection should be supported by laboratory findings.

(2) Tolnaftate is of no use in Candida or bacterial infections.

(3) It should not be applied to areas, which are acutely inflamed or infected.

(4) It may be of limited use in nail infections in conjunction with oral antifungals. Nails should be trimmed to facilitate use of solution and prevent spread of infection.

(5) It is less effective with hyperkeratotic lesions. Treat areas alternately with 10 percent salicylic acid ointment and tolnaftate.

(6) It is useful in tinea versicolor, although relapses are common with all types of therapy.

d. **Adverse Effects.** Adverse effects are relatively rare, although local irritation characterized by erythema, pruritis, and a burning sensation may occur. In such cases, the drug should be discontinued.

e. **Supply.** Tolnaftate solution is a nonaqueous 1 percent solution for dermatological use only.

6-13. **NYSTATIN**

a. **Indications.**

(1) Nystatin (Mycostatin; Nilstat) is indicated in the treatment of Candida albicans (candidiasis, moniliasis, and thrush) infections of the skin, mucous membranes, vagina, and gastrointestinal tract. This is often associated with prolonged therapy with broad-spectrum antibiotics.

(2) Nystatin may be given with other antibiotics and may be indicated with prolonged broad-spectrum antibiotics or steroid therapy to prevent superinfections.

b. **Usual Dosage.**

(1) **Oral.**

(a) Tablets--500,000 units to 1,000,000 units tid.

(b) Suspension--5 ml (500,000 units) swished in mouth and swallowed qid.
(2) **Topical.** Ointment or cream—applied locally 3 to 4 times daily.

(3) **Vaginally.** 100,000 to 200,000-units daily for 2 weeks.

c. **Cautions and Warnings.**

   (1) Nystatin is not absorbed from the GI tract and is not suitable for systemic fungal infections.

   (2) Drug should be discontinued if client develops local irritation following topical administration.

d. **Adverse Reactions.** Adverse reactions are relatively rare, although local irritation may occur following topical application. Diarrhea may be associated with large oral doses.

e. **Supply.** Nystatin is supplied as nystatin oral suspension (100,000 units/ml), nystatin tablets (oral 500,000-unit tablets and vaginal 100,000-unit tablets), nystatin ointment (100,000-units/grams), nystatin topical powder (100,000-units/grams), and nystatin cream (100,000-units/grams). It is also available in a topical combination of nystatin and triamcinolone acetonide cream.

6-14. **IODOCHLORHYDOXYQUIN AND HYDROCORTISONE**

a. **Indications.** Iodochlorhydroxyquin and hydrocortisone (Vioform-HC) is possibly effective in the control of acute and chronic inflammatory skin diseases, particularly when complicated by bacterial, protozoal, and the following fungal conditions: tinea palmaris, t. pedis, t. cruris, t. corporis, t. axillaris, and candidiasis.

b. **Usual Dosage.** Apply a small amount to affected areas 3 or 4 times daily.

c. **Cautions and Warnings.**

   (1) This preparation should not be used in the eye or topically in the presence of tuberculosis, vaccinia, varicella, or other viral skin conditions.

   (2) The client should be warned that this preparation may stain the skin, hair, and clothing yellow.

   (3) Prolonged use of this combination product can lead to the toxicities associated with hydrocortisone. Because of this fact, the client should be switched to plain iodochlorhydroxyquin, if available, when inflammation is no longer present.

d. **Adverse Reactions.**

   (1) Local burning, irritation, and itching have been noted.
(2) This product may cause staining of the skin, hair, and clothing.

e. Supply.

(1) Cream: Three percent iodochlorhydroxyquin with 0.5 percent or 1 percent hydrocortisone, 28.35 grams (1 oz).

(2) Ointment: Three percent iodochlorhydroxyquin with 1 percent hydrocortisone, 5 grams.

**NOTE:** The cream has a slightly drying effect, which is useful for moist, weeping lesions. The ointment is especially indicated for dry lesions accompanied by thickening and scaling of the skin.

6-15. SELENIUM SULFIDE LOTION

a. Indications. Selenium sulfide lotion (Selsun) is indicated for the treatment of:

(1) Common dandruff.

(2) Mild to moderately severe seborrheic dermatitis.

(3) Tinea versicolor.

b. Usual Dosage.

(1) Dandruff or seborrheic dermatitis:

(a) Lather 1 to 2 teaspoonfuls into wet scalp.

(b) Allow to remain 2 to 5 minutes.

(c) Rinse thoroughly.

(d) Repeat procedure.

(e) After treatment, wash hands.

(f) Make two applications each week for 2 weeks, then decrease frequency to maintain control.

(2) Tinea versicolor:

(a) Apply sufficient amounts to cover affected areas of body (except face). Allow to remain 5 minutes and rinse thoroughly.
(b) Lather face and allow suspension to remain 10 minutes; then rinse thoroughly.

(c) After treatment, wash hands.

(d) This procedure should be done once daily for 3 successive days. For persistent or recurring cases, the procedure may be repeated.

c. **Cautions and Warnings.**

   (1) Toxic if taken orally, but little toxic effect topically.

   (2) Irritating to mucous membranes.

   (3) Do not allow contact with eyes or genital region.

   (4) Unpleasant odor and taste.

   (5) Should be a 4-day lapse prior to use following tinting, dyeing, or waving hair.

   (6) May cause excessive oiliness of hair.

   (7) May tint gray hair orange because of incomplete rinsing.

d. **Adverse Effects.**

   (1) Discontinue use if skin sensitivity occurs.

   (2) Chemical conjunctivitis can occur if allowed to enter the eye.

   (3) Application to acutely inflamed scalp may result in cutaneous absorption with possible systemic toxic effects, which include nervousness, drowsiness, convulsions, death from vasomotor and respiratory depression.

e. **Supply.** Selenium sulfide lotion is supplied as a 2.5-percent suspension in a 4-fl oz container.

6-16. **UNDECYLENIC ACID**

   a. Undecylenic acid (Desenex) is a fungistat, which is used to treat athlete's foot and ringworm of the body. Since it is only fungistatic and not fungicidal, attention must be directed to other hygiene, especially where there are raw lesions. Fungicidal foot powder and undecylenic acid ointment both contain, in addition, the astringent zinc undecylate to help reduce rawness and irritation. Response of athlete's foot to the drug is often dramatic, but the infection sometimes persists despite treatment.
b. Undecylenic acid is available as a 10 percent solution in 59-ml bottles; as an ointment in 1-ounce (28.35-gram) containers; and as a 1 percent foot powder in 1-ounce (28.35-gram) containers.

Section IV. ANTIMALARIAL DRUGS

6-17. MALARIA

a. **Cause and Transmission.** Malaria is caused by a microbe called the plasmodium. There are four principal species of malaria-producing plasmodia—*P. falciparum*, which caused about 84 percent of the cases of malaria contracted by Americans in Vietnam; *P. vivax*, a more benign plasmodium which caused about 85 percent of the cases of malaria contracted in the United States in 1971; *P. malariae*, which causes the form of malaria called quartan malaria; and *P. ovale*, a plasmodium rarely seen except in certain parts of South America and East and West Africa. These parasites are generally transmitted by the Anopheles mosquito, of which there are many species. (An important method of defense against malaria, in addition to control of the mosquito and its environment, is personal measures taken to avoid mosquito bites.) In addition to transmission by mosquitoes, malaria may also be transmitted in a blood transfusion or in a contaminated needle used for an injection.

b. **Progression of Malaria in Man.** After a person has been infected with malaria by a mosquito, there is a latent period called the tissue stage, when the parasites, or schizonts, are multiplying in liver cells. This stage without overt effects generally lasts from 10 days to 6 weeks, depending on the type of malaria, but may last as long as several months. Eventually, however, the parasites, now called merozoites, enter the red blood cells, where they develop into small, ring-shaped forms called trophozoites. The trophozoites grow rapidly and fill the cells, and some of them develop into still other forms, sexual forms called gametocytes. During this stage, called the erythrocytic stage, many of the red blood cells burst and the typical symptoms of malaria—a chill followed by a fever, profuse sweating, headache, and backache—ensue. Meanwhile, some of the schizonts may remain in the liver, and, if not destroyed, cause a relapse of the disease even when the parasites in the blood have been destroyed by drugs. The details of the life cycle of the *Plasmodium* are illustrated in Figure 6-1.
6-18. CLASSIFICATION OF ANTIMALARIAL DRUGS

Antimalarial drugs are often classified according to the stage in the life cycle of the Plasmodium against which they are capable of acting. The categories are the primary tissue schizonticides, the secondary tissue schizonticides, the blood schizonticides, the gametocides, and the sporontocides.

a. Antimalarial Drugs Beneficial in the Treatment of Clinical Malaria.

(1) Primary tissue schizonticides. These drugs destroy the primary tissue schizonts in the liver soon after infection by the mosquito. An example is primaquine.
(2) **Secondary tissue schizonticides.** These drugs destroy the secondary tissue schizonts in the liver and thus prevent the relapsing fevers characteristic of *P. vivax*, *P. malariae*, and *P. ovale* (but not characteristic of *P. falciparum*, the most lethal form of malaria). Primaquine serves this purpose also.

(3) **Blood schizonticides.** These drugs destroy the schizonts and merozoites in the red blood cells and thus relieve the symptoms of malarial infection. They include quinine, quinacrine, and chloroquine. These drugs are often capable of curing malaria because of *P. falciparum*.

**b. Drugs Useful in the Prevention of Transmission of Malaria.** The following two categories of drugs do not necessarily help the immediate client, but they do help prevent transmission to other people by way of mosquitoes.

(1) **Gametocides.** These drugs (primaquine is an example of this category too) prevent mosquitoes from acquiring the infection from a client by destroying the gametocytes in the client's blood.

(2) **Sporontocides.** The sporontocidal drugs (for example, pyrimethamine) act inside the mosquito after it has ingested the client's blood. They prevent the reproduction of the zygote, the formation of sporozoites.

### 6-19. CHLOROQUINE AND PRIMAQUINE PHOSPHATE TABLETS

**a. Action and Uses.** The standard chloroquine-primaquine (CP) tablet is used for malaria prophylaxis in all geographic areas where malaria is endemic. Each tablet contains 500-mg of chloroquine phosphate (equivalent to 300-mg of chloroquine base), which is a blood schizonticide for all four types of malaria mentioned above. It is thus used to prevent the appearance of symptoms of malaria. The 79-mg of primaquine phosphate (equivalent to 45 mg of primaquine base) in each tablet acts to destroy the primary tissue schizonts of *P. falciparum* or *P. vivax* and the secondary tissue schizonts of the malarias characterized by relapses, that is, *P. vivax*, *P. malariae*, and *P. ovale*. (Thus, primaquine can be used to cure malaria as well as to prevent it or treat its symptoms. However, CP tablets should NOT be used for therapy of acute attacks of malaria. The toxic effects of taking more than one CP tablet in 1 day are severe.)

**b. Usual Dosage.**

(1) **Adults and children over 100 pounds:** One tablet weekly on the same day of each week, starting at least 1 day before entering the area. After leaving the area, continue this schedule (one tablet weekly) for 8 weeks.
(2) Younger children: Make a suspension of two CP tablets in 75-ml of water so that each 5-ml equals 40-mg of chloroquine base and 6-mg of primaquine base.

<table>
<thead>
<tr>
<th>Children’s weekly dose:</th>
<th>10-15 pounds</th>
<th>=</th>
<th>1/2 tsp</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-25 pounds</td>
<td>=</td>
<td>1 tsp</td>
<td></td>
</tr>
<tr>
<td>26-35 pounds</td>
<td>=</td>
<td>1 1/2 tsp</td>
<td></td>
</tr>
<tr>
<td>36-45 pounds</td>
<td>=</td>
<td>2 tsp</td>
<td></td>
</tr>
<tr>
<td>46-55 pounds</td>
<td>=</td>
<td>2 1/2 tsp</td>
<td></td>
</tr>
<tr>
<td>56-100 pounds</td>
<td>=</td>
<td>1/2 tablet</td>
<td></td>
</tr>
</tbody>
</table>

C. Adverse Effects. Occasionally, CP tablets produce intestinal cramps and loose stools. Serious hematologic effects have been reported with G6PD deficiency. Diarrhea can be handled by breaking up tablets, taking with meals or cheese, or combating with Lomotil if other measures fail.

d. Cautions and Warnings.

(1) The CP tablet should not be used in the treatment of malaria.

(2) Some individuals may respond to the primaquine in the CP tablet with a hemolytic reaction. If this happens and is severe enough, plain chloroquine tablets at the same dosage may be substituted for prophylaxis.

(3) Concurrent use of quinacrine with primaquine may cause agranulocytosis.

(4) Dapsone, 25-mg daily, may be used as an adjunct to the CP tablet in resistant falciparum areas.

6-20. CHLOROQUINE

a. Indications. Chloroquine (Aralen) is a blood schizonticide indicated in the:

(1) Treatment of uncomplicated attacks of malaria except resistant P. falciparum.

(2) Parenteral treatment of severe malaria illness except resistant P. falciparum.

(3) Prophylaxis and suppression of malaria while in an endemic area.

NOTE: This drug is also indicated for treatment of discoid lupus erythematosus, rheumatoid arthritis, and extraintestinal amebiasis.
b. **Usage Dosage.** Oral administration is preferred whenever possible.

   (1) **Prophylaxis of malaria:** 500-mg (300-mg base) once weekly, beginning 2 weeks before exposure and continuing for 8 weeks after last exposure in endemic area.

   (2) **Oral administration for treatment of malaria:** One gram (2 tablets) to start, followed by one tablet (0.5 -gram) in 6 hours. One tablet is then given daily for the next two days. Total dosage is four doses over a 3-day period for a total of 2.5-grams of chloroquine phosphate (1.5-grams of chloroquine base).

   (3) **Parenteral administration in critically ill malaria clients:** One 5-ml ampule equivalent to 200--mg of base is given intramuscularly. This may be repeated in 6 hours, but total parenteral dosage in first 24 hours should not exceed 4 ampules or 800-mg of chloroquine base.

   (4) **For blackwater fever in areas where drug resistance has not been encountered:** 200-mg base diluted with 40--ml of normal saline given slowly intravenously.

c. **Adverse Effects.**

   (1) Mild transient headaches, pruritis, anorexia, blurring of the vision, vertigo, diarrhea, malaise, and urticaria have been infrequently reported.

   (2) Signs of acute chloroquine intoxication include myocardial depression, disturbances in cardiac conduction, arrhythmias, hypotension, CNS stimulation with convulsion, and eventual paralysis of vital brain centers.

d. **Cautions and Warnings.**

   (1) Chloroquine is extremely toxic for young children. The toxic dose for children is 20 mg/kg and the lethal dose is 100-mg/kg.

   (2) Prolonged use of large doses of chloroquine has commonly produced retinal changes or visual impairment after several months or years of treatment.

   (3) Chloroquine accumulates in the liver and should be used with caution in clients with liver disease.

   (4) It is contraindicated in clients with psoriasis.

   (5) Avoid its use in pregnancy unless there is an overwhelming need for it.

   (6) Chloroquine may color urine rusty yellow or brown.
e. **Supply.**

(1) **Chloroquine phosphate tablets**, 0.5-gram (each contains 300-mg of base).

(2) **Chloroquine hydrochloride injection**, 5-ml ampules containing equivalent of 200-mg of base.

6-21. **PRIMAQUINE**

a. **Uses.** Since primaquine, a tissue schizonticide, is not effective against blood schizonts, it will not provide immediate relief to acute symptoms of malaria such as fever. However, it is capable of preventing infection because of P. falciparum if it is administered soon after the mosquito bite. It is used along with blood schizonticides in radical (complete) cures of the relapsing malarias, that is, those due to P. vivax, P. malariae, and P. ovale. Unfortunately, there are some strains of P. vivax, which are partially resistant to primaquine. Since primaquine inhibits gametocytes, it is effective in preventing the transmission of malaria to other persons by way of mosquitoes.

b. **Toxicity.**

(1) **Primaquine sensitivity.** Some people have an inherited sensitivity to primaquine because of a deficiency of a substance called G6PD, which is important to metabolism in the red blood cells. They may react to large doses of primaquine with chills, malaise, and weakness, resulting from hemolysis. The incidence of this deficiency is much greater among people whose ancestors have lived in areas where malaria due to P. falciparum is common. These people include blacks, Greeks, Iranians, Sardinians, and Sephardic Jews. The prophylactic dose, such as that found in the CP tablet, seldom causes any intense reaction. However, when these groups are treated with primaquine for preexisting malarial infections, that is, when the doses are greater, the clients should be observed closely for hemolysis. Each such client receiving primaquine should be told to report signs of hemolysis, such as red or dark coloration of the urine.

(2) **Side effects.** The side effects of primaquine may include difficulty in focusing, itching, nausea, headache, and abdominal cramps (which antacids relieve). Some blood disorders may occur.

c. **Contraindications.** Primaquine should not be given to clients with a tendency toward active rheumatoid arthritis, granulocytopenia, lupus erythematosus, or any very serious systemic disease. Primaquine should not be given concurrently with quinacrine or any drug, which depresses the bone marrow. Large doses of primaquine should usually be avoided.

d. **Dosage.** Primaquine is given orally. The usual dose is one tablet daily for 14 days.
6-22. **DAPSONE**

a. **Indications.** Dapsone (Avolsulfon) is indicated:

   (1) In all forms of leprosy.

   (2) In combination with other antimalarial agents for the treatment of resistant *Plasmodium falciparum*.

b. **Usual Dosage.**

   (1) **Leprosy**—initiate small oral doses during the first few weeks until a maintenance dose of 50-mg/day is achieved. Clients should be hospitalized for the first few weeks of therapy and should be treated by a specialist.

   (2) **Malaria**—25-mg daily for 21 to 28 days in combination with other antimalarials (quinine and pyrimethamine).

c. **Cautions and Warnings.**

   (1) It is not rapidly effective in terminating acute attacks of malaria.

   (2) It is not effective against *P. falciparum* gametocytes, *P. vivax*, or primary tissue forms of *P. falciparum*.

   (3) If used alone in treatment of malaria, parasites rapidly develop resistance to the drug.

   (4) Periodic blood checks should be performed during entire period of therapy. If anemia develops, the drug should be stopped and anemia treated.

   (5) Use with caution in persons with a G6PD deficiency, as dapsone can precipitate a hemolytic reaction.

d. **Adverse Reactions.** Dapsone can produce a wide range of adverse reactions affecting the GI tract, the blood, skin, central nervous system, and the liver:

   (1) Nausea, vomiting, headache, psychosis.

   (2) Liver enlargement and damage.

   (3) Skin rashes.
(4) Hemolysis and methemoglobinemia.

e. **Supply.** Dapsone tablets each contain 25-mg of dapsone.

6-23. **QUININE**

a. **Uses.** Quinine is used to treat acute attacks of malaria because of strains of *P. falciparum* resistant to chloroquine. It can also suppress the symptoms of an acute attack of the other three types of malaria (*P. vivax*, *P. malariae*, and *P. ovale*), but since it does not kill the tissue schizonts, it is incapable of curing these three relapsing malarias. When quinine is used to treat chloroquine- resistant strains of *P. falciparum*, it is more effective when combined with pyrimethamine or dapsone and pyrimethamine.

b. **Administration as an Antimalarial.**

(1) Oral dosage. Two quinine sulfate tablets (324-mg per tablet) are given three times daily after meals for 14 days. Care must be exercised not to use old tablets of quinine, which may have hardened, since such tablets will fail to be absorbed in the bowel.

(2) Intravenous administration. One 2-ml ampule of quinine dihydrochloride injection (containing 300-mg per ml) is diluted in 300-ml of normal saline, dextrose-saline, plasma, or other intravenous fluid appropriate to the client's condition, and given slowly (not less than 30 minutes), since low blood pressure may occur if it is infused too rapidly. The blood pressure and pulse should be monitored constantly while the infusion is running to detect a fall in blood pressure or the appearance of an abnormal rhythm of the pulse. This dosage may be repeated every 6 to 8 hours, as necessary, but not more than three such doses (a total of 2-gm of quinine dihydrochloride) should be administered during a 24-hour period. Oral administration should be substituted or resumed as soon as possible. If falciparum malaria recurs a few days after treatment with quinine, re-administration as described above may be required for a duration of 10 to 21 days.

c. **Toxicity.**

(1) If too much quinine is used, an effect called cinchonism results. Cinchonism may include headache, ringing of the ears, symptoms of cerebral congestion, flushing, sweating, nausea, diarrhea, and blurred vision. When it is severe, there may be deafness, skin rashes, drowsiness, damage to vision, cardiac arrhythmia, and abdominal pain.

(2) Administration of quinine can cause effects such as GI discomfort when given orally, painful noninfected abscesses when given IM, and damage to the lining of the blood vessels and even clotting when given IV.

(3) Some authorities believe that quinine is responsible for the condition called blackwater fever, found among people where malaria is endemic. It is
characterized by black or red-colored urine. This is due to hemolysis, which in turn leads to sludging in the kidney tubules. From 25 percent to 50 percent of the victims of black-water fever die.

(4) Quinine causes hemolysis in about 1 in every 2000 people. Quinine can also cause other blood disorders.

(5) Massive hemolysis followed by kidney failure has occurred in pregnant women after large doses of quinine. Pregnant women, nearing the time to give birth, who have shown a sensitivity to quinine or who have ever had tinnitus (characterized by false sounds in the ears), a hemolytic episode, atrial fibrillation, or optic neuritis should be warned to stay out of areas where there are strains of *P. falciparum* treatable only with quinine. No pregnant woman should ever take quinine.

(6) The lethal dose of quinine is about 8 gm.

d. **Supply.** The drug is available as 324-mg quinine sulfate tablets and as 2-ml ampules of quinine dihydrochloride injection (300-mg per ml).

**6-24. PYRIMETHAMINE**

a. **Uses.** Pyrimethamine (Daraprim), if administered for at least 10 weeks, can produce a suppressive cure of an infection with one of the relapsing malarias. However, it acts too slowly to be useful in relieving acute attacks. It can be used weekly for suppressive prophylaxis against malaria and for its sporonticidal effects, which deter the transmission of the infection from a person who already has malaria. Given concurrently with quinine sulfate or dapsone or both, it can quickly terminate acute attacks of chloroquine-resistant *falciparum* malaria in nonimmune clients and also make a relapse less likely. Pyrimethamine is also sometimes used in combination with oral sulfonamides to treat toxoplasmosis (infection with organisms of the genus *Toxoplasma*, one of which causes enlargement of the spleen and progressive anemia).

b. **Usual Dosage.**

(1) For malarial prophylaxis, one 25-mg tablet is given orally each week to adults.

(2) For the treatment of resistant *Plasmodium falciparum*, the drug is administered orally in a dosage of 25-mg twice daily for three days in combination with quinine or dapsone.

(3) For the treatment of toxoplasmosis in the adult, the starting dose is 50 to 75-mg daily combined with 1 to 4-grams of a sulfonamide drug (that is, sulfadiazine). This dosage is continued for 1 to 3 weeks. The dosage may then be reduced to about one-half that previously given for each drug and continued for an additional 4 to 5 weeks.
c. **Cautions and Warnings.**

   (1) Do not administer to pregnant women, clients with oliguria, liver disease, heart disease, or allergy to pyrimethamine.

   (2) Overdosage may cause hypotension, arrhythmias of the heart, and shock.

   (3) Because this is a folic acid antagonist, it tends to cause bone marrow depression when given at high doses. Periodic blood counts should be run. If signs appear, then the drug dosage should be reduced.

d. **Adverse Reactions.** Anorexia, vomiting, megaloblastic anemia, and bone marrow depression with leukopenia and thrombocytopenia have been observed.

e. **Supply.** Pyrimethamine is supplied in 25-mg tablets.

6-25. **SULFADOXINE AND PYRIMETHAMINE**

a. **Uses.** Sulfadoxine and pyrimethamine (Fansidar) is used in the treatment of plasmodium falciparum malaria in clients in whom chloroquine resistance is suspected and for the prophylaxis of malaria for travelers to areas where chloroquine-resistant plasmodium falciparum malaria is endemic.

b. **Usual Dosage.**

   (1) For treatment of malaria, adults take 2 or 3 tablets in a single dose alone or in sequence with quinine regimen.

   (2) For prophylaxis of malaria for travelers in endemic areas, adults take one tablet one or two days before departure and then take one tablet weekly during the stay and for 4 to 6 weeks after return.

c. **Cautions and Warnings.**

   (1) Fatalities have been associated with sulfadoxine/pyrimethamine use. Discontinue use if skin rash appears, if the count of any formed blood elements is reduced significantly, or if active bacterial or fungal infections occur.

   (2) Clients must maintain adequate fluid intake to prevent crystalluria and stone formation.

   (3) Take contraceptive measures to avoid pregnancy during therapy.

   (4) Avoid breastfeeding during therapy.
d. **Adverse Reactions.** Agranulocytosis, aplastic anemia, stomatitis, nausea, emesis, abdominal pains, headache, peripheral neuritis, erythema multiforme, Stevens-Johnson syndrome, generalized skin eruptions, drug fever, and chills have been observed.

e. **Supply.** Sulfadoxine and pyrimethamine (Fansidar) are supplied as scored tablets containing 500 mg sulfadoxine and 25-mg pyrimethamine.

### Section V. ANTHELMINTIC DRUGS

#### 6-26. INTRODUCTION

An anthelmintic is a drug used to counteract infections with worms or helminths. There are two phyla (categories) of helminths--the nemathelminths (roundworms) and the platyhelminths (flatworms, a phylum composed of flukes and tapeworms). Roundworms are also called nematodes. Flukes are called trematodes. Tapeworms are called cestodes.

#### 6-27. DRUGS OF CHOICE FOR SPECIFIC INFECTIONS

Below is a list of different types of helminthic infections, followed in parentheses by the common name of the infection, followed (after a dash) by the names of the drugs of choice for treating that particular infection. Names of alternate drugs for treating an infection are placed in parentheses.

- **Infections with Roundworms.**

  1. *Ascaris lumbricoides* (giant intestinal roundworm)--paperazine, mebendazole (or pyrantel pamoate).

  2. *Ancylostoma duodenale* (hookworm, Old World type)--mebendazole (or pyrantel pamoate).

  3. *Necator americanus* (hookworm, tropical type)--mebendazole.

  4. *Strongyloides stercoralis* (threadworm)--thiabendazole (or perhaps pyrvinium pamoate).

  5. *Enterobius vermicularis* (pinworm)--pyrantel pamoate (or mebendazole).

(7) **Trichinella spiralis** (trichinosis)--ACTH, corticosteroids, or thiabendazole. The effectiveness of thiabendazole against trichinosis is not established.

(8) **Wuchereria bancrofti** (filaria) or **W. (Brugia) malayi**--diethylcarbamazine.

(9) **Onchocerca volvulus** (onchocerciasis)--suramin plus diethylcarbamazine. Suramin is available for investigational use only.

b. **Infections with Tapeworms.**

(1) **Taenia saginata** (beef tapeworm)--niclosamide.

(2) **Taenia solium** (pork tapeworm)--niclosamide.

(3) **Diphyllolbothrium latum** (fish tapeworm)--niclosamide.

(4) **Hymenolepis nana** (dwarf tapeworm), **H. diminuta** (rat tapeworm), and **Dipylidium caninum**--niclosamide.

c. **Infections with Flukes.** THE RECOMMENDATION OF DRUGS FOR INFECTION WITH FLUKES, AS GIVEN BELOW, IS IN SOME CASES ONLY TENTATIVE. Stibocaprate bithionol is available for investigational use only.

(1) **Schistosoma mansoni**--praziquantel.

(2) **Schistosoma japonicum**--praziquantel.

(3) **Schistosoma haematobium**--praziquantel.

**NOTE:** Infection with one of the three flukes above is called schistosomiasis.

(4) **Fasciolopsis buski** (large intestinal fluke) praziquantel or niclosamide.

(5) **Heterophyes heterophyes**--praziquantel or tetrachloroethylene.

(6) **Metagonimus yokogaway**--praziquantel or tetrachloroethylene.

(7) **Clonorchis sinensis** (liver fluke)--praziquantel.

(8) **Opisthochrus felineus**--praziquantel.

(9) **Paragonimus westermani** (lung fluke)--praziquantel (or bithionol).

(10) **Fasciola hepatica** (sheep liver fluke)--praziquantel (or bithionol).
6-28. MEBENDAZOLE

a. **Indications.** Mebendazole (Vermox) is the drug of choice for the treatment of whipworm, pinworm, roundworm, and hookworm in single or fixed infections.

b. **Usual Dosage.** The same dosage schedule applies to both adults and children. The tablets may be chewed, swallowed, or crushed and mixed with food. No special procedures, such as fasting or purging are required. If the client is not cured 3 weeks after treatment, a second treatment course is advised.

   1. Hookworm infection: One tablet morning and evening on three consecutive days.
   
   2. Pinworm infection: A single tablet given once.

c. **Cautions and Warnings.**

   1. Mebendazole is not recommended for use in pregnant women. During pregnancy, especially during the first trimester, use only if the potential benefit justifies the potential risk to the fetus.

   2. Safety and efficacy for use in children under 2 years of age have not been established.

d. **Adverse Reactions.**

   1. Transient abdominal pain and diarrhea have been observed in massive infection and expulsion of worms.

   2. Fever, a possible response to drug-induced necrosis, has been reported.

e. **Supply.** Mebendazole (Vermox) is supplied as 100-mg tablets.

6-29. DIETHYLCARBAMAZINE CITRATE

a. **Indications.** Diethylcarbamazine citrate (Hetrazan) is orally effective in the treatment of filariasis caused by *Wuchereria bancrofti, W. (Grugia) malayi* or *Loa loa*. Diethylcarbamazine also has limited usefulness in *Onchocerca volvulus* infection ("river blindness").

b. **Usual Dosage.**

   1. *W. bancrofti, W. malayi,* and *Loa loa*--2-mg/kg of body weight three times a day after meals for 3 to 4 weeks. The microfilariae in the blood are rapidly killed, but repeated courses of therapy may be required to destroy adult worms. Three to 4 weeks should be allowed between each course of therapy.
c. **Adverse Effects.** Diethylcarbamazine citrate is a relatively safe drug. The major problem is allergic reactions because of the foreign protein from the dying microfilarial worms. The intensity of these reactions can be lessened by the concomitant administration of antihistamines during the first 5 days of therapy.

d. **Cautions and Warnings.** If a client is suspected of having malaria, he should be treated with chloroquine prior to the administration of diethylcarbamazine. This drug may provoke a relapse of nonsymptomatic malaria.

e. **Supply.** Diethylcarbamazine citrate is supplied as 50-mg tablets.

### 6-30. PYRANTEL PAMOATE

a. **Indications.** Pyrantel pamoate (Antiminth) is a depolarizing neuromuscular blocking agent, resulting in spastic paralysis of the worm. It is active against *Enterobius vermicularis* (pinworm) and *Ascaris lumbricoides* (roundworm).

b. **Dosage.** A single dose of 11-mg/kg (maximum total dose of 1 gram) which corresponds to a simplified dosage regimen of 1-ml/10-lb. Pyrantel may be administered without regard to meals or time of day. Purging is not necessary. It may be taken with milk or fruit juices.

c. **Cautions and Warnings.**

   (1) Safety and efficacy for use in children under 2 years of age have not been established.

   (2) Safety in pregnant women has not been established.

d. **Adverse Effects.** Anorexia, nausea, vomiting, abdominal cramps, diarrhea, headache, dizziness, and skin rash have been observed with the administration of this medication.

e. **Supply.** Pyrantel pamoate (Antiminth) is supplied as an oral suspension containing 50-mg pyrantel per ml.

### 6-31. PIPERAZINE CITRATE

a. **Indications.** Piperazine citrate (Antepar) is an alternate drug of choice for roundworms (*Ascaris lumbricoides*) and pinworms (*Enterobius vermicularis*). Piperazine blocks the response of acetylcholine in the worm causing flaccid paralysis of the worm. The worm is then dislodged and expelled by peristalsis.

b. **Usual Dosage.** Piperazine is best taken on an empty stomach. The surface contact between drug and parasite is diminished in the presence of food.

   (1) Roundworms can be treated with 75-mg/kg daily for two consecutive days (maximum daily dose = 3.5-grams).
(2) Pinworms can be treated with 65 mg/kg daily for 7-8 consecutive days (maximum daily dose = 2.5-grams).

c. **Cautions and Warnings.**

(1) It has been reported that clients with a predisposition to grand mal or petit mal have been reported to have an exacerbation of seizures following administration of piperazine.

(2) Piperazine may be used during the third trimester of pregnancy.

d. **Adverse Reactions.** Mild adverse reactions include nausea, vomiting, mild diarrhea, abdominal pain, and headache.

e. **Supply.** Each 5-ml of piperazine citrate syrup, as available in supply channels, contains the equivalent of 0.5-gram of piperazine hexahydrate.

---

**6-32. NICLOSAMIDE**

a. **Indications.** Niclosamide inhibits oxidative phosphorylation in cestodes. The scolex and segments are killed on contact with the drug. It is effective in the treatment of *Taenia saginata* (beef tapeworm), *Diphyllobothrium latum* (fish tapeworm), and *Hymenolepis nana* (dwarf tapeworm).

b. **Usual dosage.** Tablets should be thoroughly chewed, then swallowed with a small amount of water. No special dietary restrictions are required although niclosamide should be taken after a light meal. Segments of the ova may be present in the stool for up to 3 days following treatment. A second course of therapy should be administered if ova are still present after 7 days following therapy. A client is not cured unless the stool has been negative for a minimum of 3 months.

<table>
<thead>
<tr>
<th>T. saginata and D. latum (beef and fish tapeworm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
</tr>
<tr>
<td>Children</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hymenolepis nana (dwarf tapeworm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
</tr>
<tr>
<td>Children</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
c. **Cautions and Warnings.**

   (1) Safety for use during pregnancy has not been established.

   (2) Safety and efficacy for use in children under 2 years of age have not been established.

d. **Adverse Reactions.** Nausea and vomiting, abdominal discomfort, loss of appetite, drowsiness, dizziness, and skin rash have been observed.

e. **Supply.** Niclosamide (Niclocide) is supplied as 500-mg chewable tablets.

6-33. QUINACRINE

a. **Indications.** Quinacrine (Atabrine), once used extensively in the suppression and treatment of malaria, is an alternate agent used to treat infections of *Taenia saginata* (beef tapeworm), *T. solium* (pork tapeworm), and *Diphyllobothrium latum* (fish tapeworm). It is also an alternate drug for the treatment of *Hymenolepis nana* (dwarf tapeworm), *H. diminuta* (rat tapeworm), and *Dipylidium caninum*.

b. **Administration for Treatment** of *Taenia saginata*, *T. solium*, and *Diphyllobothrium latum*. The client is placed on a semisolid, bland, nonfat diet for 1 day prior to administration. The client must fast at least from suppertime the evening before because the gastrointestinal tract should be as empty as possible. A saline laxative should be given about an hour before therapy is begun. Four doses of 200-mg each should be administered orally 10 minutes apart. Sodium bicarbonate, 600-mg in about 75 ml of water, should be given with each dose to reduce the tendency to nausea and vomiting. Enough saline laxative should be given 1 to 2 hours after the last dose to produce a copious evacuation, removing the worm, alive and stained yellow, from the GI tract within 4 to 10 hours. Since only one worm is usually present in Taenia infections, the discovery of the scolex (head and neck) in the stool usually indicates that the client is cured.

c. **Administration for Treatment** of *H. nana*, *H. diminuta*, and *D. caninum*. The initial treatment of these tapeworms is the same as for *Taenia* infections above. However, on the following three days after the initial treatment, 100-mg (adult dose) of quinacrine, three times daily, must be administered. It may be necessary to repeat the entire course of treatment 2 weeks later.

d. **Adverse Effects.** The use of quinacrine may result in toxic reactions such as gastrointestinal upset, skin eruptions, and mental disorders. These effects are reversible when administration of the drug is stopped. The client's skin and his urine may become stained yellow, although these effects are not toxic.

e. **Cautions and Warnings.** The drug should not be given to clients with a history of psychosis or to people with psoriasis. It is also contraindicated in clients who
are receiving primaquine. It should not be given to pregnant women because this drug readily reaches the fetus.

f. Supply. Quinacrine (Atabrine) is available as 100-mg quinacrine hydrochloride tablets.

6-34. TETRACHLOROETHYLENE

a. Indications. Tetrachloroethylene (perchloroethylene) is an alternate drug of choice for treating *Heterophyes heterophyes* (intestinal fluke).

b. Usual Dosage. A single dose of 0.12-ml/kg of body weight up to a maximum of 5-ml is given in capsule form. The client should be kept on bed rest for 4 hours following therapy. A purge should not be given as it may increase side effects and reduce effectiveness of the drug. The client must avoid alcohol and fatty foods 24 hours prior to and also after therapy. Food should be withheld during the day of therapy. Two or more treatments at 4- to 7-day intervals may be necessary to effect a complete cure.

c. Adverse Effects. This drug is relatively free of side effects if administered correctly. Nausea, vomiting, abdominal cramping, dizziness, and drowsiness may occur. Fainting and hypotensive episodes have been reported in severely anemic clients.

d. Cautions and Warnings.

   (1) It should not be taken with fatty foods or alcohol as they will increase the systemic absorption of tetrachloroethylene and side effects.

   (2) It should not be used in the treatment of small, severely ill children.

   (3) It is contraindicated in pregnancy, hepatic disease, gastroenteritis, alcoholism, and clients undergoing heavy metal therapy.

   (4) It should be stored in a cool dark place; broken capsules should not be used.

   (5) Stool specimens should be checked at the end of a week to determine effectiveness of therapy.

e. Supply. Tetrachloroethylene is supplied in 1-ml capsules.

6-35. THIABENDAZOLE

a. Indications. Thiabendazole (Mintezol) is the drug of choice for the treatment of *Strongyloides stercoralis* (threadworm) and cutaneous larva migrans (creeping
eruption, a type of nematode also), and it may be effective in the treatment of trichinosis and visceral larva migrans.

b. **Usual Dosage.** For the treatment of threadworm and cutaneous larva migrans, the usual dose is 25-mg/kg twice daily for 2 days. The maximum single dose is 1.5-grams, and the maximum total daily dose is 3.0-grams. If necessary, the course of treatment may be repeated 1 week later. For the treatment of trichinosis, the current dosage is the same as for threadworm, but the drug may be continued as long as 4 days.

c. **Adverse Reactions.** Common side effects include dizziness, anorexia, nausea, and vomiting. Less common side effects are diarrhea, abdominal cramping pains, headache, lethargy, drowsiness, and pruritus. Bradycardia, hypotension, visual disturbances, perianal rashes, tinnitus, and paresthesias occur rarely. Occasionally, the client's urine has an unaccustomed odor during treatment and 24 hours thereafter. Leukopenia, crystalluria, and hematuria have been occasionally reported, but all subsided when treatment with thiabendazole was discontinued.

d. **Contraindications and Cautions.** Experience is very limited in the effects of thiabendazole upon children weighing less than 15-kg. Alternate drugs may be indicated when there is hepatic dysfunction. Thiabendazole must be used with caution when drug-induced vomiting may be dangerous. If ascarids are present, they may become hypermotile and appear at the nose or mouth. Thiabendazole should not be used when complete mental alertness is required.

e. **Supply.** Thiabendazole is supplied as an oral suspension containing 500 mg in each 5-ml.

### 6-36. PRAZIQUANTEL

a. **Indications.** Praziquantel increases cell membrane permeability in worms, resulting in a loss of intracellular calcium, massive contractions, and paralysis of the worm's musculature. It is indicated in the treatment of infections caused by *Schistosoma mekongi*, *S. japonicum*, *S. mansoni*, and *S. hematobium* (blood flukes).

b. **Usual dosage.** Praziquantel tablets should be swallowed with some liquid during meals. Tablets should not be chewed. Three doses should be administered as a 1-day treatment in doses of 20-mg/kg. The interval between doses should not be less than 4 hours and not more than 6 hours. Dosage for children under 4 years of age has not been established.

c. **Cautions and Warnings.**

   (1) Safety in pregnancy has not been established.
(2) Praziquantel appears in breast milk. Women should not nurse on the day of treatment and during the subsequent 72 hours.

(3) Safety and efficacy in children under 4 years of age have not been established.

d. Adverse Reactions. Praziquantel is well tolerated and side effects are usually mild. The most frequently reported side effects are malaise, headache, dizziness, and abdominal discomfort.

e. Supply. Praziquantel (Biltricide) is supplied as 600 mg film-coated tablets.

Section VI. OTHER AGENTS

6-37. METRONIDAZOLE

a. Indications. Metronidazole (Flagyl) is indicated in protozoal infections caused by the following organisms:

(1) Trichomonas vaginalis in both males and females.

(2) Giardia lamblia.

(3) Entamoeba histolytica (a species of amebas).

b. Usual Dosage.

(1) Trichomoniasis--concurrent treatment of sexual partners:

   (a) Female--one tablet three times a day for 10 days.

   (b) Male--one tablet twice a day for 10 days.

(2) Giardiasis--two courses of metronidazole therapy: 500-mg daily for 5 days, repeated after a 15-day interval.

(3) Amebiasis (infection with amebas, especially E. histolytica, both intestinal infections and hepatic abscesses: 750-mg three times a day for 5 to 10 days.

c. Adverse Reactions. There is a low incidence of untoward effects. Nausea, vomiting, a metallic taste, and a darkening of the urine are the most commonly reported side effects.
d. **Cautions and Warnings.**

(1) Metronidazole is inactive against *Candida albicans* infections.

(2) A total decrease in leukocytes has been reported with therapy. Total and differential white blood cell counts should be made, especially if the client needs to undergo a second course of therapy.

(3) Clients should be warned not to consume alcohol while receiving metronidazole; it may lead to a reaction characterized by flushing, nausea and vomiting, and a feeling of impending doom.

(4) It is well tolerated in pregnancy, but should be used with caution during the first trimester.

e. **Supply.** Metronidazole is supplied as 250-mg tablets.

6-38. **GAMMA BENZENE HEXACHLORIDE (LINDANE)**

Gamma benzene hexachloride (Kwell, lindane) is very effective in the treatment of both scabies ("itch" mite) and pediculosis (lice and "crabs"). When used to treat scabies, a thin layer of the cream is rubbed into the skin from the neck to the soles of the feet (15- to 25-grams for an adult). The cream is to be left on the client for a full 24 hours before being removed. No water is to be used on the client during this time. After this 24-hour period, the client should bathe and put on clean clothing. Pruritis (itching) is usually relieved after 24 hours, and there is rarely a need for a second application. However, if necessary, a second and third application may be made at weekly intervals. Gamma benzene hexachloride is both effective and safe to use where there is secondary infection of the skin. However, subsequent treatment with a bactericide may be needed to clear up the infection. When used in the treatment of pediculosis, the cream is applied to the area that is infected with the lice (head, body, or pubic region) and is washed off the following day. A single application is usually sufficient. The drug is supplied as a 1 percent cream packaged in 60-gram containers.

*Continue with Exercises*

*Return to Table of Contents*
EXERCISES, LESSON 6

INSTRUCTIONS: Answer the following exercises by marking the lettered response that best answers the exercise or completes the incomplete statement.

After you have completed all of these exercises, turn to "Solutions to Exercises" at the end of the lesson and check your answers. For each exercise answered incorrectly, reread the material referenced with the solution.

1. For systematic effect, streptomycin is given by which of the following routes?
   a. Any of the below
   b. Orally
   c. Rectally
   d. Intramuscularly

2. Which of the following untoward effects may occur with the use of streptomycin?
   a. Deafness
   b. Blindness
   c. Loss of speech
   d. Loss of sense of touch

3. Personnel preparing streptomycin solutions should wear rubber gloves to protect themselves from:
   a. Resistant organisms
   b. Allergic reactions
   c. Systemic absorption of the drug
   d. Discoloration of their hands
4. Which of the following factors is likely to produce toxic effects when streptomycin is being administered?
   a. Giving it without food or milk
   b. Giving it at mealtime
   c. Giving it over a prolonged time
   d. Giving it with another antibiotic

5. Which of the following drugs exhibits ototoxic effects?
   a. All of the below
   b. Streptomycin
   c. Kanamycin
   d. Gentamicin
   e. Neomycin

6. Bacitracin is most frequently administered in which of the following ways?
   a. IM
   b. IV
   c. Orally
   d. Topically

7. Bacitracin is effective primarily against:
   a. Gram-negative bacteria
   b. Gram-positive bacteria
   c. Rickettsiae
   d. Viruses
8. A sulfonamide commonly used for treatment of infections of the genitourinary tract is:
   a. Nystatin
   b. Griseofulvin
   c. Sulfisoxazole
   d. Sulfacetamide

9. Crystalluria may be a complication of treatment with which of the following drugs?
   a. Kanamycin
   b. Primaquine
   c. Sulfisoxazole
   d. Streptomycin

10. How is griseofulvin administered?
    a. Orally
    b. Rectally
    c. Topically
    d. Parenterally

11. Tolnaftate is used topically in the treatment of athlete's foot, ringworm, and other fungal infections. However, if the scalp, nails, palms, or soles are infected, which of the following oral preparation is indicated.
    a. Nystatin
    b. Griseofulvin
    c. Sulfisoxazole
    d. Iodochlorhydroxyquin and hydrocortisone
12. Which of the following drugs is indicated in the treatment of candidiasis?
   
   a. Tolnaftate
   
   b. Nystatin
   
   c. Griseofulvin
   
   d. Selenium sulfide

13. Which of the following is indicated in the treatment of common dandruff, seborrheic dermatitis, and tinea versicolor?

   a. Nystatin

   b. Selenium sulfide

   c. Undecylenic acid

   d. Iodochlorhydroxyquin and hydrocortisone

14. At the time that an infected Anopheles mosquito bites a person, the malaria parasite introduced into the person is called a:

   a. Merozoite

   b. Gametocyte

   c. Schizont

   d. Sporozoite

   e. Zygote
15. The clinical symptoms of malaria occur during the part of the life cycle of the malaria parasite when it is called:

   a. A merozoite
   b. An ookinete
   c. A gametocyte
   d. A schizont
   e. A sporozoite

16. A particular antimalarial drug, which falls into only one of the categories below, will relieve symptoms of malaria, but it will not cure or prevent an infection with one of the relapsing malarias. It is a:

   a. Primary tissue schizonticide
   b. Secondary tissue schizonticide
   c. Blood schizonticide
   d. Gametocide
   e. Sporonticide

17. A CP tablet is taken once every:

   a. Hour
   b. Day
   c. Week
   d. Month
18. What is the preferred method for the administration of chloroquine?
   a. Oral
   b. Subcutaneous
   c. Intramuscular
   d. Intravenous

19. When chloroquine is given orally to treat malaria, a course of treatment consists of:
   a. 4 doses
   b. 8 doses
   c. 16 doses
   d. 24 doses

20. According to some authorities, which drug is responsible for blackwater fever?
   a. Quinine
   b. Quinacrine
   c. Primaquine
   d. Chloroquine

21. Which of the following dose regimens of chloroquine phosphate would ordinarily be sufficient to produce a significant danger of eye damage?
   a. A weekly dose of 500 mg given for long-term prophylaxis
   b. A total of 2.5 gm given in divided doses over a period of 3 days
   c. Large doses given in short-term treatment
   d. Large doses given chronically
22. A drug that is effective in preventing transmission of malaria because it kills the sexual form of the parasite is:
   a. Chloroquine
   b. Quinine
   c. Quinacrine
   d. Primaquine

23. What drug is used for the treatment of leprosy and, in combination with quinine and pyrimethamine, for chloroquine-resistant falciparum malaria?
   a. Chloroquine
   b. Primaquine
   c. Quinacrine
   d. Dapsone

24. The blood schizonticide quinine is used to treat acute attacks of malaria resistant to which drug?
   a. Chloroquine
   b. Dapsone
   c. Primaquine
   d. Quinacrine

25. What is the drug of choice for treating the giant intestinal roundworm?
   a. Niclosamide
   b. Mebendazole
   c. Quinacrine
   d. Thiabendazole
26. Which of the following drugs should not be given concurrently with quinacrine?
   a. Quinine
   b. Chloroquine
   c. Primaquine
   d. Metronidazole

27. A drug that stains tapeworms yellow is:
   a. Quinacrine
   b. Quinine
   c. Piperazine citrate
   d. Pyrantel pamoate

28. The disease that results from infection with *E. histolytica* is:
   a. Amebiasis
   b. Typhoid fever
   c. Rocky Mountain spotted fever
   d. Typhus fever

29. When gamma benzene hexachloride is applied to treat scabies, the person should not bathe until after:
   a. 4 hours
   b. 12 hours
   c. 24 hours
   d. 3 days

*Check Your Answers on Next Page*
SOLUTIONS TO EXERCISES, LESSON 6

1. d (para 6-2b)
2. a (para 6-2d(1))
3. b (para 6-2d(2))
4. c (para 6-2d(1), (2))
5. a (paras 6-1; 6-2d(1); 6-3d(2); 6-4a; 6-5)
6. d (para 6-5)
7. b (para 6-5)
8. c (para 6-8a(1))
9. c (para 6-8c(2), d(3))
10. a (para 6-11b)
11. b (para 6-12a)
12. b (para 6-13a)
13. b (para 6-15a)
14. d (fig. 6-1)
15. a (para 6-17b, fig. 6-1)
16. c (para 6-18a(3))
17. c (para 6-19b(1))
18. a (para 6-20b)
19. a (para 6-20b(2))
20. a (para 6-23c(3))
21. d (para 6-20d(2))
22. d (paras 6-17b; 6-18b(1); 6-21a)
23. d (paras 6-22a; 6-23a; 6-24a)
24. a (para 6-23a)
25. b (paras 6-27a(1), 6-31a)
26. c (paras 6-33e, 6-21c)
27. a (para 6-33b)
28. a (para 6-37b(3))
29. c (para 6-38)

Return to Table of Contents