Appendix I. Therapeutic Recommendations (Reprinted from The Medical Letter)
DRUGS FOR PARASITIC INFECTIONS

Parasitic infections are found throughout the world. With increasing travel, immigration, use of immunosuppressive drugs, and the spread of AIDS, physicians anywhere may see infections caused by previously unfamiliar parasites. The table below lists first-choice and alternative drugs for most parasitic infections. Adverse effects of antiparasitic drugs are listed on page 120. For information on the safety of antiparasitic drugs in pregnancy, see The Medical Letter Handbook of Antimicrobial Therapy, 1992, page 151.

**DRUGS FOR TREATMENT OF PARASITIC INFECTIONS**

<table>
<thead>
<tr>
<th>Infection</th>
<th>Drug</th>
<th>Adult Dosage</th>
<th>Pediatric Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMEBIASIS</strong> (Entamoeba histolytica) asymptomatic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Iodoquinol</td>
<td>650 mg tid x 20d</td>
<td>30-40 mg/kg/d in 3 doses x 20d</td>
</tr>
<tr>
<td>OR Paromomycin</td>
<td>25-30 mg/kg/d in 3 doses x 7d</td>
<td>25-30 mg/kg/d in 3 doses x 7d</td>
<td></td>
</tr>
<tr>
<td>Alternative:</td>
<td>Diloxanide furate</td>
<td>500 mg tid x 10d</td>
<td>20 mg/kg/d in 3 doses x 10d</td>
</tr>
<tr>
<td>Drugs of choice:</td>
<td>Metronidazole</td>
<td>750 mg tid x 10d</td>
<td>35-50 mg/kg/d in 3 doses x 10d</td>
</tr>
<tr>
<td>OR Tinidazole</td>
<td>2 grams/d x 3d</td>
<td>50 mg/kg (max. 2 grams) qd x 3d</td>
<td></td>
</tr>
<tr>
<td><strong>severe intestinal disease</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drugs of choice:</td>
<td>Metronidazole</td>
<td>750 mg tid x 10d</td>
<td>35-50 mg/kg/d in 3 doses x 10d</td>
</tr>
<tr>
<td>OR Tinidazole</td>
<td>600 mg bid x 5d</td>
<td>50 mg/kg (max. 2 grams) qd x 3d</td>
<td></td>
</tr>
<tr>
<td>Alternative:</td>
<td>Dehydroemetine</td>
<td>1 to 1.5 mg/kg/d (max. 90 mg/d) IM for up to 5d</td>
<td>1 to 1.5 mg/kg/d (max. 90 mg/d) IM in 2 doses for up to 5d</td>
</tr>
<tr>
<td><strong>hepatic abscess</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drugs of choice:</td>
<td>Metronidazole</td>
<td>750 mg tid x 10d</td>
<td>35-50 mg/kg/d in 3 doses x 10d</td>
</tr>
<tr>
<td>OR Tinidazole</td>
<td>800 mg tid x 5d</td>
<td>60 mg/kg (max. 2 grams) qd x 3d</td>
<td></td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Dehydroemetine</td>
<td>1 to 1.5 mg/kg/d (max. 90 mg/d) IM for up to 5d</td>
<td>1 to 1.5 mg/kg/d (max. 90 mg/d) IM in 2 doses for up to 5d</td>
</tr>
<tr>
<td>followed by chloroquine phosphate</td>
<td>600 mg base (1 gram)/d x 2d, then 300 mg base (500 mg)/d x 2-3 wks</td>
<td>10 mg base/kg (max. 300 mg base)/d x 2-3 wks</td>
<td></td>
</tr>
</tbody>
</table>

**AMEBIC MENINGOENCEPHALITIS, PRIMARY**

| Naegleria Drug of choice:      | Amphotericin B         | 1 mg/kg/d IV, uncertain duration   | 1 mg/kg/d IV, uncertain duration      |
| Acanthamoeba Drug of choice:  | See footnote 7          |                                    |                                       |

* The letter d stands for day.
1. Dosage and duration of administration should not be exceeded because of possibility of causing optic neuritis; maximum dosage is 2 grams/day.
2. In the USA, this drug is available from the CDC Drug Service, Centers for Disease Control and Prevention, Atlanta, Georgia 30333; telephone: 404-639-3670 (evenings, weekends, and holidays: 404-639-2888).
3. Treatment should be followed by a course of iodoquinol or one of the other intraluminal drugs used to treat asymptomatic amebiasis.
4. A nitro-imidazole similar to metronidazole, but not marketed in the USA; tinidazole appears to be at least as effective as metronidazole and better tolerated. Ornidazole, a similar drug, is also used outside the USA.
6. An approved drug, but considered investigational for this condition by the U.S. Food and Drug Administration

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## Therapeutic Recommendations

<table>
<thead>
<tr>
<th>Infection</th>
<th>Drug</th>
<th>Adult Dosage*</th>
<th>Pediatric Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anisakiasis</strong></td>
<td>Anisakis (Anisakis)</td>
<td></td>
<td></td>
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<tr>
<td><strong>Angiostrongyliasis</strong></td>
<td>Angiostonglylus cantonensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Mebendazole&lt;sup&gt;6,8&lt;/sup&gt;</td>
<td>100 mg bid x 5d</td>
<td>100 mg bid x 5d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;6,8&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 3d (max. 3 grams/d)&lt;sup&gt;10&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 3d (max. 3 grams/d)&lt;sup&gt;10&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Ascariasis</strong></td>
<td>Ascaris (Ascaris lumbricoides)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Mebendazole</td>
<td>100 mg bid x 3d</td>
<td>100 mg bid x 3d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Pyrantel pamoate OR</td>
<td>11 mg/kg once (max. 1 gram)</td>
<td>11 mg/kg once (max. 1 gram)</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Albendazole</td>
<td>400 mg once</td>
<td>400 mg once</td>
</tr>
<tr>
<td><strong>Baylisascariasis</strong></td>
<td>Baylisascaris procyonis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;10&lt;/sup&gt;</td>
<td>1.2 grams bid parenteral or 600 mg tid oral x 7d</td>
<td>20-40 mg/kg/d in 3 doses x 7d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Metronidazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>650 mg tid oral x 7d</td>
<td>25 mg/kg/d in 3 doses x 7d</td>
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<tr>
<td><strong>Babesiosis</strong></td>
<td>Babesia microti</td>
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<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Clindamycin&lt;sup&gt;6&lt;/sup&gt;</td>
<td>500 mg qid x 10d</td>
<td>40 mg/kg/d in 4 doses x 10d (max. 2 grams/d)&lt;sup&gt;12&lt;/sup&gt;</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Idoxquinol&lt;sup&gt;1,6&lt;/sup&gt;</td>
<td>650 mg tid x 20d</td>
<td>40 mg/kg/d in 3 doses x 20d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Metronidazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>750 mg tid x 5d</td>
<td>35-50 mg/kg/d in 3 doses x 5d</td>
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<tr>
<td><strong>Balantidiasis</strong></td>
<td>Balantidium coli</td>
<td></td>
<td></td>
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<tr>
<td>Drug of choice:</td>
<td>Tetracycline&lt;sup&gt;8&lt;/sup&gt;</td>
<td>200 mg bid x 20d</td>
<td>200 mg bid x 20d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Albenazole</td>
<td>200 mg bid x 10d</td>
<td>200 mg bid x 10d</td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Thiabendazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
</tr>
<tr>
<td><strong>Blastocystis hominis</strong></td>
<td>Blastocystis hominis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>200 mg tid oral x 10d</td>
<td>200 mg tid oral x 10d</td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Metronidazole</td>
<td>500 mg tid oral x 10d</td>
<td>500 mg tid oral x 10d</td>
</tr>
<tr>
<td><strong>Baylisascariasis</strong></td>
<td>Baylisascaris procyonis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>200 mg bid x 10d</td>
<td>200 mg bid x 10d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Metronidazole</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
</tr>
<tr>
<td><strong>Chagas' disease</strong></td>
<td>See Trypanosomiasis</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cryptosporidiosis</strong></td>
<td>Cryptosporidium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>200 mg bid x 10d</td>
<td>200 mg bid x 10d</td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Metronidazole</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
</tr>
<tr>
<td><strong>Cutaneous Larva Migrans</strong></td>
<td>Creeping eruption, dog hookworm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;17&lt;/sup&gt;</td>
<td>200 mg bid x 3d</td>
<td>200 mg bid x 3d</td>
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<tr>
<td>Alternatives:</td>
<td>Albendazole&lt;sup&gt;17&lt;/sup&gt;</td>
<td>200 mg bid x 3d</td>
<td>200 mg bid x 3d</td>
</tr>
<tr>
<td><strong>Cyclospora infection</strong></td>
<td>Cyclospora</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Trimethoprim-sulfamethoxa­</td>
<td>TMP 160 mg,</td>
<td>200 mg bid x 3d</td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Sulfate&lt;sup&gt;19&lt;/sup&gt;</td>
<td>SMX 800 mg bid x 3 days</td>
<td>200 mg bid x 3 days</td>
</tr>
<tr>
<td><strong>Cryptosporidiosis</strong></td>
<td>Cryptosporidium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Thiabendazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>200 mg bid x 10d</td>
<td>200 mg bid x 10d</td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Albendazole&lt;sup&gt;6&lt;/sup&gt;</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
<td>25 mg/kg/d in 2 doses x 30d</td>
</tr>
</tbody>
</table>

* The letter d stands for day.


8. Effective documented only in animals.

9. Most patients recover spontaneously without antiparasitic drug therapy. Analgesics, corticosteroids, and careful removal of CSF at frequent intervals can relieve symptoms (J Koo et al, Rev Infect Dis, 10:1155, 1988). Albendazole, levamisole (Ergamisol), or ivermectin has also been used successfully in animals.

10. This dose is likely to be toxic and may have to be decreased.

11. Exchange transfusion has been used in severely ill patients with high (>10%) parasitemia (V lacopino and T Earnhart, Arch Intern Med, 150:1527, 1990). One report indicates that azithromycin (Zithromax), 500-1000 mg daily, plus quinine may also be effective (LM Weiss et al, J Infect Dis, 168:1289, 1993). Concurrent use of pentamidine and trimethoprim-sulfamethoxazole has been reported to cure an infection with B. divergens (D Raoul et al, Ann Intern Med, 107:944, 1987).

12. Not recommended for use in children less than eight years old.

13. Drugs that could be tried include diethylcarbamazine, levamisole, and fenbendazole (KR Kazacos, J Am Vet Med Assoc, 195:894, 1989) and ivermectin. Steroid therapy may be helpful, especially in eye or CNS infection. Ocular baylisascariasis has been treated successfully using laser therapy to destroy intraretinal larvae.

14. Clinical significance of these organisms is controversial, but metronidazole 750 mg tid x 10d or iodoquinol 650 mg tid x 20d anecdotally have been reported to be effective (I Grossman et al, Am J Gastroenterol, 87:729, 1992; PFL Boreham and O Stenzel, Adv Parasitol, 32:2, 1993).

15. Infection is self-limited in immunocompetent patients. In HIV-infected patients with large-volume intractable diarrhea, octreotide (Sandostatin) 300-500 μg tid subcutaneously may control the diarrhea, but not the infection (JD Cello et al, Ann Intern Med, 115:705, 1991). Paromomycin may sometimes be helpful (K Armitaga et al, Arch Intern Med, 152:2497, 1992). In unpublished clinical trials, azithromycin, 1250 mg daily for two weeks followed by 500 mg daily, has apparently been effective in some patients.

16. Several reports suggest that ivermectin, 150-200 μg/kg once, is also effective (E Caumes et al, Arch Dermatol, 128:994, 1992).


<table>
<thead>
<tr>
<th>Infection</th>
<th>Drug</th>
<th>Adult Dosage*</th>
<th>Pediatric Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CYSTICERCOSIS, see TAPEWORM infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DIENTAMOEBA fragilis infection</td>
<td>lodoquinol*</td>
<td>650 mg tid x 20d</td>
<td>40 mg/kg/d in 3 doses x 20d</td>
</tr>
<tr>
<td></td>
<td>OR Paromomycin</td>
<td>25-30 mg/kg/d in 3 doses x 7d</td>
<td>25-30 mg/kg/d in 3 doses x 7d</td>
</tr>
<tr>
<td></td>
<td>OR Tetracycline</td>
<td>500 mg qid x 10d</td>
<td>40 mg/kg/d (max. 2 grams/d) in 4 doses x 10d</td>
</tr>
<tr>
<td>Diphyllobothrium latum. see TAPEWORM infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRACUNCULUS medinensis (guinea worm) infection</td>
<td>Metronidazole*</td>
<td>250 mg tid x 10d</td>
<td>25 mg/kg/d (max. 750 mg/d) in 3 doses x 10d</td>
</tr>
<tr>
<td>Alternative:</td>
<td>Thiabendazole*</td>
<td>50-75 mg/kg/d in 2 doses x 3d</td>
<td>50-75 mg/kg/d in 2 doses x 3d</td>
</tr>
<tr>
<td>Echinococcus, see TAPEWORM infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entamoeba histolytica, see AMEBIASIS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTAMOEBA polecki infection</td>
<td>Metronidazole*</td>
<td>750 mg tid x 10d</td>
<td>35-50 mg/kg/d in 3 doses x 10d</td>
</tr>
<tr>
<td>ENTEROBISIUS vermicularis (pinworm) infection</td>
<td>Pyrantel pamoate</td>
<td>11 mg/kg once (max. 1 gram); repeat after 2 weeks</td>
<td>11 mg/kg once (max. 1 gram); repeat after 2 weeks</td>
</tr>
<tr>
<td>OR Mebendazole</td>
<td></td>
<td>A single dose of 100 mg; repeat after 2 weeks</td>
<td>A single dose of 100 mg; repeat after 2 weeks</td>
</tr>
<tr>
<td>OR Albendazole</td>
<td>400 mg once; repeat in 2 weeks</td>
<td>400 mg once; repeat in 2 weeks</td>
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<tr>
<td>Fasciola hepatica, see FLUKE infection</td>
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<tr>
<td>FILARIASIS</td>
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<td>Wuchereria bancrofti, Brugia malayi</td>
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<tr>
<td>Drug of choice:</td>
<td></td>
<td></td>
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<tr>
<td>Diethylcarbamazine</td>
<td>Day 1: 50 mg, oral, p.c.</td>
<td>Day 1: 1 mg/kg, oral, p.c.</td>
<td></td>
</tr>
<tr>
<td>Day 2: 50 mg tid</td>
<td>Day 2: 1 mg/kg tid</td>
<td></td>
<td></td>
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<tr>
<td>Day 3: 100 mg tid</td>
<td>Day 3: 1-2 mg/kg tid</td>
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<td></td>
</tr>
<tr>
<td>Days 4 through 21:</td>
<td>Days 4 through 21:</td>
<td>6 mg/kg/d in 3 doses</td>
<td>6 mg/kg/d in 3 doses</td>
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<tr>
<td>6 mg/kg/d in 3 doses</td>
<td></td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Loa loa</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Drug of choice:</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Diethylcarbamazine</td>
<td>Day 1: 50 mg, oral, p.c.</td>
<td>Day 1: 1 mg/kg, oral, p.c.</td>
<td></td>
</tr>
<tr>
<td>Day 2: 50 mg tid</td>
<td>Day 2: 1 mg/kg tid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 3: 100 mg tid</td>
<td>Day 3: 1-2 mg/kg tid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days 4 through 21:</td>
<td>Days 4 through 21:</td>
<td>9 mg/kg/d in 3 doses</td>
<td>9 mg/kg/d in 3 doses</td>
</tr>
<tr>
<td>Mansorrela ochsard</td>
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<td>Mansorrela perstans</td>
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</tr>
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<td>Mebendazole*</td>
<td>100 mg bid x 30d</td>
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</tr>
<tr>
<td>Tropical Pulmonary Eosinophilia (TPE)</td>
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</tr>
<tr>
<td>Drug of choice:</td>
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<td></td>
<td></td>
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<tr>
<td>Diethylcarbamazine</td>
<td>6 mg/kg/d in 3 doses x 21d</td>
<td>6 mg/kg/d in 3 doses x 21d</td>
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</tr>
<tr>
<td>Onchocerca volvulus</td>
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<td>Drug of choice:</td>
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<td></td>
<td></td>
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<tr>
<td>Ivermectin*</td>
<td>150 µg/kg oral once, repeated every 6 to 12 months</td>
<td>150 µg/kg oral once, repeated every 6 to 12 months</td>
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</tr>
<tr>
<td>FLUKE, hermaphroditic infection</td>
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<tr>
<td>Clonorchis sinensis (Chinese liver fluke)</td>
<td></td>
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<tr>
<td>Drug of choice:</td>
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</tr>
<tr>
<td>Praziquantel</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td></td>
</tr>
<tr>
<td>Fasciola hepatica (sheep liver fluke)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bithionol*</td>
<td>30-50 mg/kg on alternate days x 10-15 doses</td>
<td>30-50 mg/kg on alternate days x 10-15 doses</td>
<td></td>
</tr>
</tbody>
</table>

* The letter d stands for day.
20. Not curative, but decreases inflammation and facilitates removing the worm. Mebendazole 400-800 mg/d for 6d has been reported to kill the worm directly.
22. Antihistamines or corticosteroids may be required to decrease allergic reactions due to disintegration of microfilariae in treatment of filarial infections, especially those caused by Loa loa.
23. For patients with no microfilariae in the blood or skin, full doses can be given from day one.
25. Diethylcarbamazime has no effect. Ivermectin, 150 µg/kg, may be effective (TB Nutman et al, J Infect Dis, 156:622, 1987).
<table>
<thead>
<tr>
<th>Infection</th>
<th>Drug</th>
<th>Adult Dosage*</th>
<th>Pediatric Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FLUKE, hermaphroditic, infection (continued)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Fasciolopsis buski</em> (intestinal fluke)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Praziquantel&lt;sup&gt;6&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
</tr>
<tr>
<td>OR Niclosamide&lt;sup&gt;6&lt;/sup&gt;</td>
<td>a single dose of 4 tablets (2 g), chewed thoroughly</td>
<td>11-34 kg: 2 tablets (1 g), &gt;34 kg: 3 tablets (1.5 g)</td>
<td></td>
</tr>
<tr>
<td><strong>Heterophyes heterophyes</strong> (intestinal fluke)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Praziquantel&lt;sup&gt;6&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
</tr>
<tr>
<td><strong>Metagonimus yokogawai</strong> (intestinal fluke)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Praziquantel&lt;sup&gt;6&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
</tr>
<tr>
<td><strong>Necator americanus</strong> (intestinal fluke)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Praziquantel&lt;sup&gt;6&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
</tr>
<tr>
<td><strong>Paragonimus westermani</strong> (lung fluke)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Praziquantel&lt;sup&gt;6&lt;/sup&gt;</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
<td>75 mg/kg/d in 3 doses x 1d</td>
</tr>
<tr>
<td>Alternative:&lt;sup&gt;27&lt;/sup&gt;</td>
<td>Bithionol&lt;sup&gt;2&lt;/sup&gt;</td>
<td>30-50 mg/kg on alternate days x 10-15 doses</td>
<td>30-50 mg/kg on alternate days x 10-15 doses</td>
</tr>
<tr>
<td><strong>GIARDIASIS</strong> (<em>Giardia lamblia</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Metronidazole&lt;sup&gt;8&lt;/sup&gt;</td>
<td>250 mg tid x 5d</td>
<td>15 mg/kg/d in 3 doses x 5d</td>
</tr>
<tr>
<td>Alternatives:&lt;sup&gt;28&lt;/sup&gt;</td>
<td>Quinacrine HCl</td>
<td>100 mg tid p.c. x 5d (max. 300 mg/d)</td>
<td>6 mg/kg/d in 3 doses p.c. x 5d (max. 300 mg/d)</td>
</tr>
<tr>
<td>OR Tinidazole&lt;sup&gt;4&lt;/sup&gt;</td>
<td>2 grams once</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR Furazolidone</td>
<td>100 mg qid x 7-10d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR Paromomycin&lt;sup&gt;19&lt;/sup&gt;</td>
<td>25-30 mg/kg/d in 3 doses x 7d</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GNATHOSTOMIASIS</strong> (_ Gnathostoma spinigerum_</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment of choice:&lt;sup&gt;30&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>plus Surgical removal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HOOKWORM infection</strong> (<em>Ancylostoma duodenale, Necator americanus</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Mebendazole</td>
<td>160 mg TMP, 800 mg SMX qid x 10d, then bid x 3 wks</td>
<td></td>
</tr>
<tr>
<td>OR Pyrantel pamoate&lt;sup&gt;6&lt;/sup&gt;</td>
<td>100 mg bid x 3d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR Albendazole&lt;sup&gt;31&lt;/sup&gt;</td>
<td>400 mg once</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hydatid cyst, see TAPEWORM infection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hymenolepis nana, see TAPEWORM infection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ISOSPORIASIS</strong> (<em>Isospora belli</em>)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Trithromoprim-sulfamethoxazole&lt;sup&gt;6,32&lt;/sup&gt;</td>
<td>160 mg TMP, 800 mg SMX qid x 10d, then bid x 3 wks</td>
<td></td>
</tr>
<tr>
<td><strong>LEISHMANIASIS</strong> (<em>L. mexicana, L. tropica, L. major, L. braziliensis, L. donovani [Kala-azar])</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Sodium stibogluconate&lt;sup&gt;2&lt;/sup&gt;</td>
<td>20 mg Sb/kg/d IV or IM x 20-28d&lt;sup&gt;33&lt;/sup&gt;</td>
<td>20 mg Sb/kg/d IV or IM x 20-28d&lt;sup&gt;33&lt;/sup&gt;</td>
</tr>
<tr>
<td>OR Meglumine antimonate&lt;sup&gt;4&lt;/sup&gt;</td>
<td>20 mg Sb/kg/d x 20-28d&lt;sup&gt;33&lt;/sup&gt;</td>
<td></td>
<td>20 mg Sb/kg/d x 20-28d&lt;sup&gt;33&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alternatives:&lt;sup&gt;34&lt;/sup&gt;</td>
<td>Amphotericin B&lt;sup&gt;6&lt;/sup&gt;</td>
<td>0.25 to 1 mg/kg by slow infusion daily or every 2d for up to 8 wks</td>
<td>0.25 to 1 mg/kg by slow infusion daily or every 2d for up to 8 wks</td>
</tr>
<tr>
<td>OR Pentamidine isothionate&lt;sup&gt;6&lt;/sup&gt;</td>
<td>2-4 mg/kg daily or every 2d IM for up to 15 doses&lt;sup&gt;33&lt;/sup&gt;</td>
<td></td>
<td>2-4 mg/kg daily or every 2d IM for up to 15 doses&lt;sup&gt;33&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* The letter d stands for day.
27. Unpublished data indicate triclabendazole may be effective in a dosage of 5 mg/kg once daily for 3 days or 10 mg/kg twice in one day.
28. Albendazole 400 mg daily x 5d has also been reported to be highly effective against giardiasis (A Hall and Q Nahar, Trans R Soc Trop Med Hyg, 87:84, 1993).
29. Not absorbed and not highly effective, but may be useful for treatment of giardiasis in pregnancy.
30. Ivermectin has been reported to be effective in animals (MT Anantaphruti et al, Trap Med Parasitol, 43:65, 1992).
32. In sulfonamide-sensitive patients, such as some HIV-infected patients, pyrimethamine 50-75 mg daily has been effective (LM Weiss et al, Ann Intern Med, 109:474, 1988). In immunocompromised patients, it may be necessary to continue therapy indefinitely.
33. May be repeated or continued. A longer duration may be needed for some forms of visceral leishmaniasis.
MALARIA. **Treatment of (continued)**

**All Plasmodium except Chloroquine-resistant *P. falciparum**

**ORAL**

<table>
<thead>
<tr>
<th>Infection</th>
<th>Drug</th>
<th>Adult Dosage*</th>
<th>Pediatric Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. falciparum</em></td>
<td>Chloroquine phosphate</td>
<td>600 mg base (1 gram), then 300 mg base (500 mg) 6 hrs later, then 300 mg base (500 mg) at 24 and 48 hrs</td>
<td>10 mg base/kg (max. 600 mg base), then 5 mg base/kg 6 hrs later, then 5 mg base/kg at 24 and 48 hrs</td>
</tr>
</tbody>
</table>

**PARENTERAL**

<table>
<thead>
<tr>
<th>Drug of choice</th>
<th>Quinine phosphate</th>
<th>same as above</th>
<th>same as above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quinidine gluconate</td>
<td>same as above</td>
<td>same as above</td>
<td></td>
</tr>
</tbody>
</table>

**Prevention of relapses: *P. vivax* and *P. ovale***

| Drug of choice | Primaquine phosphate | 15 mg base (26.3 mg)/d x 14d or 45 mg base (79 mg)/wk x 8 wks | 0.3 mg base/kg/d x 14d |

**MALARIA. Prevention of Chloroquine-sensitive areas**

**Drug of choice: Chloroquine phosphate**

<table>
<thead>
<tr>
<th>Adult Dosage*</th>
<th>Pediatric Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 mg base (500 mg salt) orally, once/week</td>
<td>5 mg/kg base (8.3 mg/kg salt) once/week, up to adult dose of 300 mg base</td>
</tr>
</tbody>
</table>

**Chloroquine-resistant areas**

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>Mefloquine</th>
<th>250 mg oral once/week</th>
<th>15-19 kg: ¼ tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR</td>
<td>Doxycycline</td>
<td>100 mg daily</td>
<td>20-30 kg: ¼ tablet</td>
</tr>
<tr>
<td>Chloroquine phosphate</td>
<td>same as above</td>
<td>31-45 kg: ½ tablet</td>
<td>&gt;45 kg: 1 tablet</td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Chloroquine phosphate</td>
<td>Carry a single dose (3 tablets) for self-treatment of febrile illness when medical care is not immediately available</td>
<td>&lt;1 yr: ¼ tablet</td>
</tr>
<tr>
<td>Chloroquine phosphate</td>
<td>same as above</td>
<td>1-3 yrs: ½ tablet</td>
<td>&lt;2 yrs: 50 mg daily</td>
</tr>
<tr>
<td>OR</td>
<td>Doxycycline</td>
<td>200 mg daily</td>
<td>4-8 yrs: 1 tablet</td>
</tr>
<tr>
<td>Quinine dihydrochloride</td>
<td>same as above</td>
<td>9-14 yrs: 2 tablets</td>
<td>2-6 yrs: 100 mg daily</td>
</tr>
<tr>
<td>Primaquine phosphate</td>
<td>0.3 mg base/kg (max. 600 mg base).</td>
<td>&lt;2 yrs: 50 mg daily</td>
<td>7-10 yrs: 150 mg daily</td>
</tr>
<tr>
<td>OR</td>
<td>Doxycycline</td>
<td>0.3 mg base/kg (max. 600 mg base).</td>
<td>&gt;10 yrs: 200 mg daily</td>
</tr>
<tr>
<td>Quinine dihydrochloride</td>
<td>same as above</td>
<td>0.3 mg base/kg (max. 600 mg base).</td>
<td></td>
</tr>
</tbody>
</table>

* The letter d stands for day.

52. If chloroquine phosphate is not available, hydroxychloroquine sulfate is as effective; 400 mg of hydroxychloroquine sulfate is equivalent to 500 mg of chloroquine phosphate.

53. In *P. falciparum* malaria, if the patient has not shown a response to conventional doses of chloroquine in 48-72 hours, parasitic resistance to this drug should be considered. *P. vivax* with decreased susceptibility to chloroquine has been reported from New Guinea (KH Rieckmann et al, Lancet, 2:1183, 1989) and from Indonesia (IK Schwartz et al, N Engl J Med, 324:927, 1991); a single dose of mefloquine, 15 mg/kg, has been recommended to treat these infections.

54. Some relapses have been reported with this regimen; relapses should be treated with chloroquine plus primaquine, 30 mg base/d x 14 days.

55. Primaquine phosphate can cause hemolytic anemia, especially in patients whose red cells are deficient in glucose-6-phosphate dehydrogenase. This deficiency is most common in African, Asian, and Mediterranean peoples. Patients should be screened for G-6-PD deficiency before treatment. Primaquine should not be used during pregnancy.

56. No drug regimen guarantees protection against malaria. If fever develops within a year (particularly within the first two months) after travel to malarious areas, travelers should be advised to seek medical attention. Insect repellents, insecticide-impregnated bed nets, and proper clothing are important adjuncts for malaria prophylaxis.

57. In pregnancy, chloroquine prophylaxis has been used extensively and safely, but the safety of other prophylactic antimalarial agents in pregnancy is unclear. Therefore, travel during pregnancy to chloroquine-resistant areas should be discouraged.

58. For prevention of attack after departure from areas where *P. vivax* and *P. ovale* are endemic, which includes almost all areas where malaria is found (except Haiti), some experts prescribe in addition primaquine phosphate 15 mg base (26.3 mg)/d or, for children, 0.3 mg base/kg/d during the last two weeks of prophylaxis. Others prefer to avoid the toxicity of primaquine and rely on surveillance to detect cases when they occur, particularly when exposure was limited or doubtful. See also footnotes 54 and 55.

59. Beginning one week before travel and continuing weekly for the duration of stay and for four weeks after leaving.

60. The pediatric dosage has not been approved by the FDA, and the drug has not been approved for use during pregnancy. Women should take contraceptive precautions while taking mefloquine and for two months after the last dose. Mefloquine is not recommended for children weighing less than 15 kg, or for patients with cardiac conduction abnormalities. Patients with a history of seizures or psychiatric disorders and those whose occupation requires fine coordination or spatial discrimination should probably avoid mefloquine (Medical Letter, 32:13, 1990). Resistance to mefloquine has been reported in some areas, such as Thailand; in these areas, doxycycline should be used for prophylaxis.

61. Beginning one day before travel and continuing for the duration of stay and for four weeks after leaving. Use of tetracyclines is contraindicated in pregnancy and in children less than eight years old. Doxycycline can cause gastrointestinal disturbances, vaginal moniliasis and photosensitivity reactions.

62. Proguanil (Paludrine – Ayerst, Canada; ICI, England), which is not available in the USA but is widely available overseas, is recommended mainly for use in Africa south of the Sahara. Prophylaxis is recommended during exposure and for four weeks afterwards. Failures in prophylaxis with chloroquine and proguanil have been reported in travelers to Kenya (AJ Barnes, Lancet, 338:1338, 1991).
### Therapeutic Recommendations

#### Microsporidiosis

| Infection | Drug | Adult Dosage* | Pediatric Dosage*
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocular (Encephalitozoon hellem, Nosema corneum)</td>
<td>Fumagillin (Fumidil-B)</td>
<td>TMP 15-20 mg/kg/d, SMX 75-100 mg/kg/d, oral or IV in 3 or 4 doses x 14-21d</td>
<td>Same as adult dose</td>
</tr>
<tr>
<td>Intestinal (Enterocytozoon bieneusi, Septata intestinalis)</td>
<td>Octreotide (Sandostatin)</td>
<td>3-4 mg/kg IV qd x 14-21 days</td>
<td>Same as adult dose</td>
</tr>
<tr>
<td>Disseminated (Encephalitozoon hellem, Encephalitozoon cuniculi Pleistophora sp.)</td>
<td>Albendazole</td>
<td>5 mg/kg PO q6h x 21 days</td>
<td>100 mg PO qd x 21 days</td>
</tr>
<tr>
<td>Mites, see Scabies</td>
<td>Albendazole</td>
<td>15 mg/kg PO q6h</td>
<td>750 mg tid PO x 21d</td>
</tr>
<tr>
<td>Moniliformis moniliformis infection</td>
<td>N-Acidic</td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Naegleria species, see Amebic Meningoencephalitis, Primary</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Necator americanus, see Hookworm infection</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Oesophagostomum bifurcum</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Onchocerca volvulus, see Filariasis</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Opisthorchis viverrini, see Fluke infection</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Paragonimus westermani, see Fluke infection</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Pediculus capitis, humanus, Phthirus pubis, see Lice</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Pinworm, see Enterobius</td>
<td></td>
<td>100 mg PO qd</td>
<td>300-450 mg PO</td>
</tr>
<tr>
<td>Pneumocystis carinii pneumonia</td>
<td>Trimethoprim-sulfamethoxazole OR Pentamidine</td>
<td>45 mg/m^2 IV qd x 21 days</td>
<td>20 mg/m^2 PO or IV q6h x 21 days</td>
</tr>
<tr>
<td>Primary and secondary prophylaxis</td>
<td>Trimethoprim-sulfamethoxazole</td>
<td>1 DS tab PO qd or 3x/week</td>
<td>Respirgard II nebulizer or System 22 Mizer Jet Nebulizer</td>
</tr>
<tr>
<td>Alternatives:</td>
<td>Dapsone</td>
<td>25-50 mg PO qd, or 100 mg PO 2x/week</td>
<td></td>
</tr>
<tr>
<td>Aerosol pentamidine</td>
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</tr>
</tbody>
</table>

* The letter d stands for day.

63. Ocular lesions due to *E. hellem* in HIV-infected patients have responded to fumagillin eyedrops prepared from *Fumidil-B*, a commercial product used to control a microsporidal disease of honey bees, available from Mid-Continent Agrimarketing, Inc., Lenexa, Kansas 66215 (MC Diesenhouse, Am J Ophthalmol, 115:293, 1993). Fumagillin from other sources has also been used successfully (DF Rosberger et al, Cornea, 12:261, 1993). In one report, a keratopathy due to *E. hellem* in an HIV-infected patient was treated successfully with surgical debridement, topical antibiotics, and itraconazole (RW Yee et al, Ophthalmology, 98:196, 1991). For lesions due to *N. corneum*, topical therapy is generally not effective and keratoplasty may be required (RM Davis et al, Ophthalmology, 97:953, 1990).


65. No established treatment


67. HIV-infected patients should be treated for 21 days. In severe disease with room air PO$_2$ ≤ 70 mmHg or Aa gradient ≥ 35 mmHg, prednisone should also be used (Medical Letter, 35:79, 1993).

68. For patients who have failed or are intolerant to standard therapy.

69. Assay for G-6-PD deficiency recommended before therapy.

70. Recommended in mild to moderate disease (room air PO$_2$ > 60 mmHg) (W Hughes, N Engl J Med, 328:1521, 1993).
### SCABIES (Sarcoptes scabiei)

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>5% Permethrin</th>
<th>Topically</th>
<th>Topically</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternatives:</td>
<td>Lindane&lt;sup&gt;67&lt;/sup&gt;</td>
<td>Topically</td>
<td>Topically</td>
</tr>
<tr>
<td></td>
<td>10% Crotamiton</td>
<td>Topically</td>
<td>Topically</td>
</tr>
</tbody>
</table>

### SCHISTOSOMIASIS (Bilharziasis)

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>Praziquantel</th>
<th>40 mg/kg/d in 2 doses x 1d</th>
<th>40 mg/kg/d in 2 doses x 1d</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. haematobium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. japonicum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. mansoni</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug of choice:</td>
<td>Oxamnique&lt;sup&gt;61&lt;/sup&gt;</td>
<td>15 mg/kg once&lt;sup&gt;72&lt;/sup&gt;</td>
<td>20 mg/kg/d in 2 doses x 1d&lt;sup&gt;73&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alternative:</td>
<td>Praziquantel</td>
<td>60 mg/kg/d in 3 doses x 1d</td>
<td>60 mg/kg/d in 3 doses x 1d</td>
</tr>
<tr>
<td>S. mekongi</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### TAPEWORM Infection — Adult (Intestinal stage)

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>Thiabendazole</th>
<th>50 mg/kg/d in 2 doses (max. 3 grams/d) x 2d&lt;sup&gt;16,74&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50 mg/kg/d in 2 doses (max. 3 grams/d) x 2d&lt;sup&gt;16,74&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 μg/kg/d x 1-2d</td>
</tr>
</tbody>
</table>

### TAPEWORM Infection — Adult (Intestinal stage)

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>Praziquantel&lt;sup&gt;8&lt;/sup&gt;</th>
<th>5-10 mg/kg once</th>
<th>11-34 kg: a single dose of 2 tablets (1 gram); &gt;34 kg: a single dose of 3 tablets (1.5 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Niclosamide</td>
<td>A single dose of 4 tablets (2 grams), chewed thoroughly</td>
<td>25 mg/kg once</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11-34 kg: a single dose of 2 tablets (1 gram); &gt;34 kg: a single dose of 2 tablets (1.5 g)</td>
<td></td>
</tr>
</tbody>
</table>

### TAPEWORM Infection — Adult (Intestinal stage)

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>Praziquantel&lt;sup&gt;8&lt;/sup&gt;</th>
<th>50 mg/kg/d in 3 doses x 15d</th>
<th>50 mg/kg/d in 3 doses x 15d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Niclosamide</td>
<td>15 mg/kg/d in 3 doses x 28d, repeated as necessary</td>
<td>15 mg/kg/d in 3 doses x 28d, repeated as necessary</td>
</tr>
</tbody>
</table>

### STRONGYLIDIASIS (Strongyloides stercoralis)

<table>
<thead>
<tr>
<th>Drug of choice:</th>
<th>Albendazole&lt;sup&gt;76,77&lt;/sup&gt;</th>
<th>400 mg bid x 28 days, repeated as necessary</th>
<th>15 mg/kg/d x 28 days, repeated as necessary</th>
</tr>
</thead>
</table>

### TOXOPLASMOsis (Toxoplasma gondii)<sup>81</sup>

| Drugs of choice: | Pyrimethamine | 25-100 mg/d x 3-4 wks | 2 mg/kg/d x 3d, then 1 mg/kg/d (max. 25 mg/kg/d) x 4 wks<sup>55</sup> |
|------------------|---------------|----------------------|------------------------------------------------|------------------------------------------------|
|                  | plus sulfadiazine<sup>84</sup> | 1-2 grams qid x 3-4 wks | 100-200 mg/kg/d x 3-4 wks |
|                  | Spiramycin<sup>86</sup> | 3-4 grams/d           | 50-100 mg/kg/d x 3-4 wks |

### TRICHINOSIS (Trichinella spiralis)

| Drugs of choice: | Steroids for severe symptoms plus mebendazole<sup>8,86</sup> | 200-400 mg tid x 3d, then 400-500 mg tid x 10d |

* The letter d stands for day.
71. Neuropsychiatric disturbances and seizures have been reported in some patients (H Stokvis et al, Am J Trop Med Hyg, 35:330, 1986).
72. In East Africa, the dose should be increased to 30 mg/kg, and in Egypt and South Africa, 30 mg/kg/d x 2d. Some experts recommend 40-60 mg/kg over 2-3 days in all of Africa (KC Shekhar, Drugs, 42:379, 1991).
73. In immunocompromised patients it may be necessary to continue therapy or use other agents.
74. In disseminated strongyloidiasis, thiabendazole therapy should be continued for at least five days.
76. With a fatty meal to enhance absorption. Some patients may benefit from or require surgical resection of cysts (RK Tompkins, Mayo Clin Proc, 66:1281, 1991). Praziquantel may also be useful preoperatively or in case of spill during surgery.
77. Recently, percutaneous drainage with ultrasound guidance plus albendazole therapy has been effective for management of hepatic hydatid cyst disease (MS Khuroo et al, Gastroenterology, 104:1452, 1993).
78. Surgical excision is the only reliable means of treatment, although some reports have suggested use of albendazole or mebendazole (JF Wilson et al, Am J Trop Med Hyg, 37:162, 1987; A Davis et al, Bull WHO, 64:383, 1988).
79. Corticosteroids should be given for two to three days before and during drug therapy for neurocysticercosis. Any cisticercoidal drug may cause irreversible damage when used to treat ocular or spinal cysts, even when corticosteroids are used.
80. Albendazole should be taken with a fatty meal to enhance absorption.
81. In ocular toxoplasmosis, corticosteroids should also be used for an anti-inflammatory effect on the eyes.
**Therapeutic Recommendations**

<table>
<thead>
<tr>
<th>Infection</th>
<th>Drug</th>
<th>Adult Dosage*</th>
<th>Pediatric Dosage*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TRICHOMONIASIS</strong> <em>(Trichomonas vaginalis)</em></td>
<td>Drug of choice: Metronidazole</td>
<td>2 grams once or 250 mg tid orally x 7d</td>
<td>15 mg/kg/d orally in 3 doses x 7d</td>
</tr>
<tr>
<td></td>
<td>OR Tinidazole</td>
<td>2 grams once</td>
<td>50 mg/kg once (max. 2 grams)</td>
</tr>
<tr>
<td><strong>TRICHOSTRONGYLUS</strong> infection</td>
<td>Drug of choice: Pyrantel pamoate</td>
<td>11 mg/kg once (max. 1 gram)</td>
<td>11 mg/kg once (max. 1 gram)</td>
</tr>
<tr>
<td></td>
<td>Alternative: Mebendazole</td>
<td>100 mg bid x 3d</td>
<td>100 mg bid x 3d</td>
</tr>
<tr>
<td></td>
<td>OR Albenzole</td>
<td>400 mg once</td>
<td>400 mg once</td>
</tr>
<tr>
<td><strong>TRICHURIASIS</strong> <em>(Trichuris trichiura, whipworm)</em></td>
<td>Drug of choice: Mebendazole</td>
<td>100 mg bid x 3d</td>
<td>100 mg bid x 3d</td>
</tr>
<tr>
<td></td>
<td>OR Albenzole</td>
<td>400 mg once</td>
<td>400 mg once</td>
</tr>
<tr>
<td><strong>TRYPANOSOMIASIS</strong></td>
<td>T. cruzi <em>(South American trypanosomiasis, Chagas disease)</em></td>
<td>Drug of choice: Nifurtimox</td>
<td>8-10 mg/kg/d orally in 4 doses x 120d</td>
</tr>
<tr>
<td></td>
<td>Alternative: Benzimidazole</td>
<td>5-7 mg/kg/d x 30-120d</td>
<td>20 mg/kg on days 1,3,7,14, and 21</td>
</tr>
<tr>
<td>T. brucei gambiense; T. b. rhodesiense <em>(African trypanosomiasis, sleeping sickness)</em></td>
<td>Drug of choice: Suramin</td>
<td>100-200 mg (test dose) IV, then 1 gram IV on days 1,3,7,14, and 21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alternative: Eflornithine; see footnote 91</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>OR Efomithine; isethionate</td>
<td>4 mg/kg/d IM x 10d</td>
<td>4 mg/kg/d IM x 10d</td>
</tr>
<tr>
<td>late disease with CNS involvement</td>
<td>Drug of choice: Melarsoprol</td>
<td>2-3.6 mg/kg/d IV x 3 d; after 1 wk 3.6 mg/kg per day IV x 3d; repeat again after 10-21 days</td>
<td>18-25 mg/kg total over 1 month; initial dose of 0.36 mg/kg IV, increasing gradually to max. 3.6 mg/kg at intervals of 1-5d for total of 9-10 doses</td>
</tr>
<tr>
<td></td>
<td>Alternative: Eflornithine</td>
<td>See footnote 91</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OR Tryparsamide; suramin</td>
<td>One injection of 10 mg/kg IV every 5d to total of 12 injections; may be repeated after 1 month</td>
<td></td>
</tr>
<tr>
<td><strong>VISERIAL LARVA MIGRANS</strong></td>
<td>Drug of choice: Diethylcarbamazine</td>
<td>6 mg/kg/d in 3 doses x 7-10d</td>
<td>6 mg/kg/d in 3 doses x 7-10d</td>
</tr>
<tr>
<td></td>
<td>Alternatives: Albenzole; Mebendazole</td>
<td>400 mg bid x 3-5d</td>
<td>400 mg bid x 3-5d</td>
</tr>
</tbody>
</table>

**Whipworm**, see TRICHURIASIS

*Wuchereria bancrofti*, see FILARIASIS

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82. Pyrimethamine is teratogenic in animals. To prevent hematological toxicity from pyrimethamine, it is advisable to give leucovorin (folinic acid), about 10 mg/day, either by injection or orally. To treat CNS toxoplasmosis in HIV-infected patients, some clinicians use pyrimethamine 50 to 100 mg daily after a loading dose of 200 mg with a sulfonamide and, when sulfonamide sensitivity developed, have given clindamycin 1.8 to 2.4 g/d in divided doses instead of the sulfonamide (JS Remington et al, Lancet, 338:1142, 1991; BJ Luft et al, N Engl J Med, 329:995, 1993). Atovaquone, 750 mg qid, appears to be an effective alternative in sulfite-intolerant patients (JA Kovacs et al, Lancet, 340:637, 1992). Dapsone-pyrimethamine can prevent first episodes of toxoplasmosis (P-M Girard et al, N Engl J Med, 328:1514, 1993). In HIV-infected patients, chronic suppressive treatment should continue indefinitely (Medical Letter, 35:79, 1993).

83. Congenitally infected newborns should be treated with pyrimethamine every two or three days and a sulfonamide daily for about one year (JS Remington and G Desmons in JS Remington and JO Klein, eds. *Infectious Disease of the Fetus and Newborn Infant*, 3rd ed. Philadelphia: Saunders, 1990, page 89).

84. Available temporarily from the CDC, 404-488-4928.

85. For use during pregnancy, continue the drug until delivery.

86. Albenzole or flubendazole (not available in the USA) may also be effective.

87. Sexual partners should be treated simultaneously. Outside the USA, ornidazole has also been used for this condition. Metronidazole-resistant strains have been reported; higher doses of metronidazole for longer periods are sometimes effective against these strains (J Lossick, Rev Infect Dis, 12:S665, 1990).

88. In heavy infection it may be necessary to extend therapy for 3 days.

89. The addition of gamma interferon to nifurtimox for 20 days in a limited number of patients and in experimental animals appears to have shortened the acute phase of Chagas disease (RE McCabe et al, J Infect Dis, 163:912, 1991).

90. Limited data

91. In T. b. gambiense infections, eflornithine is highly effective in both the hemolymphatic and CNS stages. Its effectiveness in T. b. rhodesiense infections has been variable. Some clinicians have given 400 mg/kg/d IV in 4 divided doses for 14 days, followed by oral treatment with 300 mg/kg/d for 3-4 wks (F Millord et al, Lancet, 340:852, 1992).

92. In frail patients, begin with as little as 18 mg and increase the dose progressively. Pretreatment with suramin has been advocated for debilitated patients. Corticosteroids have been used to prevent arsenical encephalopathy (J Pepin et al, Lancet, 1:49, 1989).

93. For severe symptoms or eye involvement, corticosteroids can be used in addition.


95. One report of a cure using 1 gram tid for 21 days has been published (A Bekhti, Ann Intern Med, 100:463, 1984).
ADVERSE EFFECTS OF SOME ANTIPARASITIC DRUGS*

ALBENDAZOLE (Zentel)  
**Occasional:** diarrhea; abdominal pain; migration of ascari 
**Rare:** leukopenia; alopecia; increased serum transaminase activity

ATOVAQUONE (Mepron)  
**Frequent:** rash, nausea  
**Occasional:** diarrhea

BENZNIDAZOLE (Rochagan)  
**Frequent:** allergic rash; dose-dependent polyneuropathy; gastrointestinal disturbances; psychic disturbances

BITHIONOL (Bitin)  
**Frequent:** photosensitivity reactions; vomiting; diarrhea; abdominal pain; urticaria  
**Rare:** leukopenia; toxic hepatitis

CHLOROQUINE HCI and CHLOROQUINE PHOSPHATE (Aralen, and others)  
**Occasional:** pruritus; vomiting; headache; confusion; depigmentation of hair; skin eruptions; corneal opacity; weight loss; partial alopecia; extraocular muscle palsies; exacerbation of psoriasis, eczema, and other exfoliative dermatoses; myalgias; photosobia  
**Rare:** irreversible retinal injury (especially when total dosage exceeds 100 grams); discoloration of nails and mucus membranes; nerve-type deafness; peripheral neuropathy and myopathy; heart block; blood dyscrasias; hematemesis

CROTAMITON (Eurax)  
**Occasional:** rash; conjunctivitis

DEHYDROEMETINE  
**Frequent:** cardiac arrhythmias; precordial pain; muscle weakness; cellulitis at site of injection  
**Occasional:** diarrhea; vomiting; peripheral neuropathy; heart failure; headache; dyspnea

DIETHYLCARBAMAZINE CITRATE USP (Hetrazan)  
**Frequent:** severe allergic or febrile reactions in patients with microfilariae in the blood or the skin; GI disturbances  
**Rare:** encephalopathy

DIOXANIDE FUROATE (Furamide)  
**Frequent:** flatulence  
**Occasional:** nausea; vomiting; diarrhea  
**Rare:** diplopia; dizziness; urticaria; pruritus

EFLORNITHINE (Difluoromethylornithine, DFMO, Ornidy)  
**Frequent:** anemia; leukopenia  
**Occasional:** diarrhea; thrombocytopenia; seizures  
**Rare:** hearing loss

FLUBENDAZOLE – similar to mebendazole
FURAZOLIDONE (Furoxon)
Frequent: nausea; vomiting
Occasional: allergic reactions, including pulmonary infiltration, hypotension, urticaria, fever, vesicular rash; hypoglycemia; headache
Rare: hemolytic anemia in G-6-PD deficiency and neonates; disulfiram-like reaction with alcohol; MAO-inhibitor interactions; polyneuritis

HALOFANTRINE (Halfan)
Occasional: diarrhea; abdominal pain; pruritus; prolongation of QTc and PR interval

IODOQUINOL (Yodoxin)
Occasional: rash; acne; slight enlargement of the thyroid gland; nausea; diarrhea; cramps; anal pruritus
Rare: optic neuritis; optic atrophy, loss of vision, peripheral neuropathy after prolonged use in high dosage (for months); iodine sensitivity

IVERMECTIN (Mectizan)
Occasional: Mazzotti-type reaction seen in onchocerciasis, including fever, pruritus, tender lymph nodes, headache, and joint and bone pain
Rare: hypotension

LINDANE (Kwell, and others)
Occasional: eczematous rash; conjunctivitis
Rare: convulsions; aplastic anemia

MALATHION (Ovide)
Occasional: local irritation

MEBENDAZOLE (Vermox)
Occasional: diarrhea; abdominal pain; migration of ascaris through mouth and nose
Rare: leukopenia; agranulocytosis; hypospermia

MEFLOQUINE (Lariam)
Frequent: vertigo; lightheadedness; nausea; other gastrointestinal disturbances; nightmares; visual disturbances; headache
Occasional: confusion
Rare: psychosis; hypotension; convulsions; coma; paresthesias

MEGLUMINE ANTIMONATE (Glucantime) Similar to sodium stibogluconate

MELARSOPROL (Arsobal)
Frequent: myocardial damage; albuminuria; hypertension; colic; Herxheimer-type reaction; encephalopathy; vomiting; peripheral neuropathy
Rare: shock

METRONIDAZOLE (Flagyl, and others)
Frequent: nausea; headache; dry mouth; metallic taste
Occasional: vomiting; diarrhea; insomnia; weakness; stomatitis; vertigo; paresthesias; rash; dark urine; urethral burning; disulfiram-like reaction with alcohol
Rare: seizures; encephalopathy; pseudomembranous colitis; ataxia; leukopenia; peripheral neuropathy; pancreatitis

NICLOSAMIDE (Nicolid)
Occasional: nausea; abdominal pain

NIFURTIMOX (Lampit)
Frequent: anorexia; vomiting; weight loss; loss of memory; sleep disorders; tremor; paresthesias; weakness; polynu

NIFURTIMOX (Lampit)
Frequent: anorexia; vomiting; weight loss; loss of memory; sleep disorders; tremor; paresthesias; weakness; polynu

ORINDAZOLE (Tiberal)
Occasional: dizziness; headache; gastrointestinal disturbances
Rare: reversible peripheral neuropathy

OXAMNIQUE (Vensil)
Occasional: headache; fever; dizziness; somnolence; nausea; diarrhea; rash; insomnia; hepatic enzyme changes; ECG changes; EEG changes; orange-red discoloration of urine
Rare: seizures; neuropsychiatric disturbances

PAROMOMYCIN (Aminosidine; Humatin)
Frequent: GI disturbances
Occasional: eighth-nerve damage (mainly auditory); renal damage

PENTAMIDINE ISETHIONATE (Pentam 300, NebuPent)
Frequent: hypotension; hypoglycemia often followed by diabetes mellitus; vomiting; blood dyscrasias; renal damage; pain at injection site; GI disturbances
Occasional: may aggravate diabetes; shock; hypocalcemia; liver damage; cardiotoxicity; delirium; rash
Rare: Herxheimer-type reaction; anaphylaxis; acute pancreatitis; hyperkalemia

PERMETHRIN (Nix, Elimite)
Occasional: burning; stinging; numbness; increased pruritus; pain; edema; erythema; rash

PRAZIMARTE (Biltricide)
Frequent: malaise; headache; dizziness
Occasional: sedation; abdominal discomfort; fever; sweating; nausea; eosinophilia; fatigue
Rare: pruritus; rash

PRIMAQUINE PHOSPHATE USP
Frequent: hemolytic anemia in G-6-PD deficiency
Occasional: neutropenia; GI disturbances; methemoglobinemia in G-6-PD deficiency
Rare: CNS symptoms; hypertension; arrhythmias

PYRIMETHAMINE USP
Frequent: hemolytic anemia in G-6-PD deficiency
Occasional: neutropenia; GI disturbances; methemoglobinemia in G-6-PD deficiency
Rare: CNS symptoms; hypertension; arrhythmias

PROGUANIL (Paludrine)
Occasional: oral ulceration; hair loss; scaling of palms and soles; urticaria
Rare: hematuria (with large doses); vomiting; abdominal pain; diarrhea (with large doses); thrombocytopenia

PYRANTEL PAMOATE (Antiminth)
Occasional: GI disturbances; headache; dizziness; rash; fever

PYRETHRINS and PIPERONYL BUTOXIDE (RID, others)
Occasional: allergic reactions

PYRIMETHAMINE USP (Daraprim)
Occasional: blood dyscrasias; folic acid deficiency
Rare: rash; vomiting; convulsions; shock; possibly pulmonary eosinophilia; fatal cutaneous reactions with pyrimethamine-sulfadoxine (Fansidar)

* Drug interactions are generally not included here; see the current edition of The Medical Letter Handbook of Adverse Drug Interactions.
QUINACRINE HCl USP (Atabrine)
Frequent: dizziness; headache; vomiting; diarrhea
Occasional: yellow staining of skin; toxic psychosis; insomnia; bizarre dreams; blood dyscrasias; urticaria; blue and black nail pigmentation; psoriasis-like rash
Rare: acute hepatic necrosis; convulsions; severe exfoliative dermatitis; ocular effects similar to those caused by chloroquine

QUININE DIHYDROCHLORIDE and SULFATE
Frequent: cinchonism (tinnitus, headache, nausea, abdominal pain, visual disturbance)
Occasional: deafness; hemolytic anemia; other blood dyscrasias; photosensitivity reactions; hypoglycemia; arrhythmias; hypotension; drug fever
Rare: blindness; sudden death if injected too rapidly

SODIUM STIBOGLOCONATE (Pentostam)
Frequent: muscle pain and joint stiffness; nausea; transaminase elevations; T-wave flattening or inversion
Occasional: weakness; colic; liver damage; bradycardia; leukopenia
Rare: diarrhea; rash; pruritus; myocardial damage; hemolytic anemia; renal damage; shock; sudden death

SPIRAMYCIN (Rovamycin)
Occasional: GI disturbances
Rare: allergic reactions

SURAMIN SODIUM (Germanin)
Frequent: vomiting; pruritus; urticaria; paresthesias; hyperesthesia of hands and feet; photophobia; peripheral neuropathy
Occasional: kidney damage; blood dyscrasias; shock; optic atrophy

THIAMINE HYDROCHLORIDE (Mintezol)
Frequent: nausea; vomiting; vertigo
Occasional: leukopenia; crystalluria; rash; hallucinations; olfactory disturbance; erythema multiforme
Rare: shock; tinnitus; intrahepatic cholestasis; convulsions; angioneurotic edema; Stevens-Johnson syndrome

TINIDAZOLE (Fasigyn)
Occasional: metallic taste; nausea; vomiting; rash

TRIMETREXATE (with "leucovorin rescue")
Occasional: rash; peripheral neuropathy; bone marrow depression; increased serum aminotransferase concentrations

TRYPARASAMIDE
Frequent: nausea; vomiting
Occasional: impaired vision; optic atrophy; fever; exfoliative dermatitis; allergic reactions; tinnitus

* Drug interactions are generally not included here; see the current edition of The Medical Letter Handbook of Adverse Drug Interactions.
Appendix II. Procedures Suggested for Examining Clinical Specimens for Agents of Parasitic Diseases*

There is no general agreement about diagnostic laboratory procedures in clinical parasitology. Certain minimum standards have been established and employ techniques that can be used even in small clinical laboratories. However, technicians who are not experienced in diagnostic parasitology and who do not have frequent exposure to these techniques will not be able to carry out these tests reliably. It is far better under such circumstances to utilize the resources of regional reference laboratories. Nevertheless, small laboratories can be helpful in situations when speed is of the essence, as, for example, when making the diagnosis of malaria. A permanent collection of identified stained fecal and blood smears, as well as formalinized specimens of adult worms, eggs, larvae, and cysts, may be purchased initially and added to over the years, to be used as reference material.

Collection of Stool Specimens

Collection of satisfactory specimens is essential for reliability, whether the tests are done locally or elsewhere. The following procedures are suggested for proper collection of stool specimens:

1. Fresh, unpreserved feces should be obtained and transported to the laboratory immediately. Fresh specimens are preferred for examinations for trophozoites and are necessary when tests for *Strongyloides* larvae are to be performed.
2. Unpreserved feces should be examined within 1 hour after passage, especially if the stool is loose or watery and might contain protozoan trophozoites. Examination of formed feces may be delayed for a short time but must be completed on the day on which the specimen is received in the laboratory. If prompt examination or proper fixation cannot be carried out, formed specimens may be refrigerated for 1–2 days.
3. If specimens are delayed in reaching the laboratory or if they cannot be examined promptly (such as those received at night, on weekends, or when no parasitologist is available), portions should be preserved in fixatives such as 8% aqueous formalin or formol-saline or with polyvinyl alcohol (PVA). Formalin preserves cysts, eggs and larvae for subsequent wet-mount examination or for concentration tests; PVA-fixative preserves trophozoites, cysts, and eggs for subsequent permanent staining. A ratio of one part of feces to three parts of fixative is recommended. The specimen may be placed in fixatives in the laboratory, or the patient may be provided with fixatives and instructions for collection and preservation of his or her own specimens.

Methods of Stool Examination and Related Procedures

Stool specimens may be examined by the three complementary methods listed below. The advantages and limitations of each technique must be recognized.

1. Saline mounts are of value primarily for demonstrating the characteristic motility of certain amebae and flagellates. These organisms may be found in fresh uniformed stools or at times in bloody mucus adhering to the surface of formed stools. Material should be obtained from several parts of the specimen. An iodine stain (a drop of 1% iodine in 2% potassium iodide) mixed with a stool suspension in saline solution facilitates identification of protozoan cysts, but it kills and distorts trophozoites.
2. Concentration techniques, useful for detecting small numbers of cysts and helminth eggs, may be used on unpreserved stool specimens, those preserved in aqueous formalin or formol-saline, or on PVA-fixed material.

* Modified from a statement by the Council of the American Society of Parasitologists, the American Society for Medical Technologists, the Board of Scientific Advisors of the American Association of Bioanalysis, and the Board of Directors of the International Society for Clinical Laboratory Technology.
3. Stained fecal films should be made if possible on all specimens obtained fresh or fixed in PVA. If properly prepared they comprise the single most productive stool examination for protozoa. Films may be stained with trichrome solution or with iron-hematoxylin. Stained slides of positive specimens should be placed in a permanent file, analogous to those used for surgical and cytologic specimens.

**Number of Specimens Examined and Appropriate Intervals**

1. To detect amebae, a minimum of three specimens should be examined; if these samples (obtained preferably at intervals of 2–3 days) are negative and amebic infection remains a diagnostic consideration, additional specimens should be examined.

2. With suspected giardiasis, initially three specimens should be examined. If they are negative, additional specimens should be obtained at weekly intervals for 3 weeks. Duodenal aspiration or the enteric string test may also be of value for detecting occult infections.

3. A single concentrate from one stool specimen is frequently sufficient to detect intestinal helminthic infections of clinical importance. With very light *Schistosoma* sp. infections, few or no eggs may be found in the feces or urine. *Strongyloides* may also require concentrating the specimen for diagnosis, but this method is not always reliable; various fecal culture methods or the enteric string test may also be used.

4. Examination after treatment, under most circumstances, should be delayed until 1 month after completion of therapy (3 months after treatment for schistosomiasis or tapeworms).

**Examination of Blood**

1. Smears for malaria should consist of both thick and thin films. It is important that all involved laboratory personnel be aware of the technique for making thick films; if improperly made, they are useless. Smears should be stained with Giemsa solution, and a minimum of 100 microscopic fields examined before a specimen is reported negative. If the first specimen is negative, additional thick and thin films should be taken every 7 hours for 24 hours.

2. When examining for filarial infection one must consider the possibility of diurnal or nocturnal periodicity of microfilariae in the peripheral blood and obtain specimens accordingly. Thick smears or blood concentration methods are most likely to demonstrate infection.

**Serologic Methods**

A variety of immunodiagnostic methods may serve as useful adjuncts to the clinical diagnosis of parasitic infections. In some cases, serologic methods may be the only laboratory recourse for making a diagnosis. Certain serologic tests provide a high degree of diagnostic accuracy; however, mixed infections, antigen-sharing by related and unrelated parasites, and other diseases or physiologic conditions in humans may interfere with this diagnostic accuracy. Tests employing capture techniques in which monoclonal antibody are used increases the likelihood of a true positive result.

Most serum specimens may be shipped frozen or preserved with thimerosal to a final concentration of 1:10,000 to a state public health laboratory for forwarding to the Centers for Disease Control and Prevention in Atlanta, Georgia. The vial, containing at least 2 ml of serum, should indicate the preservative used.
Appendix III. Laboratory Diagnostic Methods

This section presents the most effective tests for identifying protozoan and helminthic parasites. The first part deals with unpreserved specimens and the second with preserved specimens. There is no single method for diagnosing all stages of all parasites, and often several tests must be performed to obtain optimal results.

Unpreserved Specimens

For best results the specimens should be less than 1 hour old when first examined, although it may not always be possible. Specimens that are up to 24 hours old may still be useful for recovering protozoan cysts and helminthic larvae and eggs, but trophozoites rarely survive that long. A confounding factor when examining specimens left at room temperature for more than 24 hours is that the living organism can grow and develop. Refrigeration helps prevent this problem. The specimen should not be frozen, as it would alter the morphology of the organisms examined.

Stool

Because of the daily variability in the quantity of various stages of parasite shed by the infected individual, the parasite may be missed in a single casual specimen, particularly when the infection is light. Multiple samples—generally considered a total of three specimens collected on consecutive days—are needed to detect most infections. Some parasites (e.g., the schistosomes and Giardia) tend to require more specimens for detection.

Barium or mineral oil interferes with identification of parasites. Therefore patients should not be subjected to radiographic studies involving barium or given laxatives containing mineral oil until the stool specimens have been obtained.

Direct Examination

Gross examination consists in the following steps:

1. Observe and record the appearance of the entire specimen, noting the color, consistency, and odor.
2. Examine the specimen for the presence of living parasites.
3. Perform a microscopic examination.
4. Examine a direct smear of the material.

The direct examination is most effective for diagnosing living parasites (e.g., Entamoeba histolytica, Giardia lamblia, Strongyloides stercoralis), and should be performed on loose, diarrheic, or purged stool. When motile amebae are found on a direct smear, a stained preparation should also be examined for the definitive diagnosis. (If the ameba contains erythrocytes within the cytoplasm it is E. histolytica, and stained specimens are not necessary for further identification.)

If the specimen appears negative, as may occur with light infections, it is necessary to concentrate the sample.

1. Dip a wooden applicator stick into the specimen to coat the tip of it with stool.
2. Smear the stool onto a clear glass microscope slide on which a drop of normal saline solution has been placed and overlay with a coverslip. (Smears must be thin enough to facilitate microscopic observation.)

Staining the Direct Smear. With the Wheatley-Gomori trichrome stain the protozoan nuclei stain red to dark blue, the cytoplasm stains a lighter blue, and the background material stains green. Trophozoites and cysts tend to shrink away from the background material and are therefore relatively easy to locate.

By modifying the standard mix of staining reagents, a more specific diagnosis of microsporidial agents can be made. The solution consists of 6.0 g chromotrope 2R, 0.5 g aniline blue CI42755, and 0.25 g dodecatungstophosphoric acid AR in 3 ml glacial acetic acid. The rest of the procedure of staining is as described in the text. Enterocytozoon bieneusi and Encephalit-
ozoon- or Septata-like spores stain pink-red and are easily distinguished from other organisms found in feces, including small budding yeasts. This stain is applied to a thin smear of stool on a coverslip and the coverslip is immersed sequentially in the solution enumerated below for the prescribed lengths of time.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schaudinn’s fixative</td>
<td>5 minutes at 50 °C or 1 hour at room temperature</td>
</tr>
<tr>
<td>Ethanol-iodine 70%</td>
<td>1 minute</td>
</tr>
<tr>
<td>Ethanol 70%</td>
<td>1 minute</td>
</tr>
<tr>
<td>Ethanol 70%</td>
<td>1 minute</td>
</tr>
<tr>
<td>Trichrome stain</td>
<td>2–8 minutes</td>
</tr>
<tr>
<td>Ethanol 90% (acidified)</td>
<td>10–20 seconds</td>
</tr>
</tbody>
</table>

For destaining the material, dip the coverslip in the destaining solution once or twice. Rinse in 90% ethanol to stop the destaining process. Thin smears destain quickly; thicker ones may require 3 or 4 dips to obtain optimal differentiation. The destaining process is as follows.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol 95% or 100%</td>
<td>Two rinses</td>
</tr>
<tr>
<td>Xylol</td>
<td>1 minute</td>
</tr>
</tbody>
</table>

Mount the stained–destained coverslip and examine under a microscope.

Concentration Methods

Sedimentation by Centrifugation: Formaldehyde-Ether Method. Sedimentation by concentration and exposure to formaldehyde–ether concentrates cysts and eggs of parasites by centrifugation, but debris and ether-soluble materials localize in the formaldehyde-ether interface or the ether layer in the top of the tube. (This process destroys trophozoites because they disintegrate in ether.)

1. Mix stool 1:10 with water.
2. Strain through a single layer of gauze into a 15-ml centrifuge tube.
3. Centrifuge the strained stool (1 minute at 2000 rpm) and discard the supernatant.
4. Wash the sediment once with water.
5. Repeat steps 3 and 4.
6. Discard the supernatant and save the sediment.
7. Add 10 ml of 7.5% formaldehyde to the sediment.
8. Let stand 10–30 minutes.
9. Add approximately 3 ml of ether, plug the tubes with stoppers, and agitate the mixture vigorously.
10. Remove the stoppers and centrifuge the tubes at 1500 rpm for 1 minute.
11. Gently loosen the debris from the tube wall with an applicator stick, being careful not to disturb the pellet.
12. Discard the supernatant.
13. Examine the sediment under a microscope.
14. Add a drop of 70% ethanol-iodine solution (Lugol’s solution) and examine again if internal structures of cysts are not recognized on first examination.

Many facilities have difficulty meeting the safety requirements for the use of ether. As an alternative, ethyl acetate can be used as a substitute for ether.

Sedimentation by Gravity: Water Sedimentation. The water sedimentation test is used primarily for the concentration and recovery of Schistosoma mansoni and Schistosoma japonicum eggs, and it is effective for determining their viability. An entire day’s worth of stool should be examined in a single test because schistosome eggs are shed sporadically.

1. Emulsify the entire stool sample in water.
2. Strain the specimen through a single layer of gauze into conical sedimentation flasks.
3. Allow the sediment to settle (approximately 20 minutes) and discard the supernatant.
4. Resuspend the sediment in water.
5. Repeat steps 3 and 4 until the supernatant is clear.
6. Discard the final supernatant and save the sediment.
7. Examine the entire sediment under a microscope.
8. If schistosome eggs are present, determine their viability by examining them under oil immersion or high magnification (400 ×) to determine the activity of flame cells.

The entire water sedimentation procedure should be done within 2 hours of starting it be-
cause prolonged exposure of the eggs to water stimulates them to hatch. If hatching occurs, the empty shells remain in the sediment and the ciliated miracidia can be seen moving about rapidly.

Baerman Sedimentation Method. The Baerman sedimentation method is specific for concentrating and recovering the larvae of *Strongyloides stercoralis*. The test requires a funnel with a piece of rubber tubing attached to it. An adjustable clamp is applied across the tubing, and the entire apparatus is suspended from a ring stand in a 37°C incubator. Because *Strongyloides* larvae cannot swim against gravity, they concentrate in the sediment that accumulates in the base of the rubber tube connected to the funnel and can then be expressed into a test tube for microscopic identification.

1. Break apart 5–15 g of a stool sample.
2. Place the sample in gauze and rest it in a funnel filled with water at 37°C so most of the sample is submerged.
3. Let it sit 1 hour, then drain 4 ml of the sediment into a 15-ml tube.
4. Centrifuge the sediment at 1000 rpm for 5 minutes.
5. Decant the supernatant.
6. Examine the pellet under a microscope.

Flotation by Centrifugation. Flotation methods concentrate the parasites by taking advantage of their specific gravity. The unwanted debris sediments to the bottom of the tube during centrifugation, but the diagnostic forms float to the surface. Cysts and most eggs can be recovered in large quantities by this method, but trophozoites, operculated eggs, and schistosome eggs are either destroyed or sediment to the bottom of the tube.

The zinc sulfate flotation method is performed as follows.

1. Mix 1 part stool in 15 ml of water in a 15-ml centrifuge tube.
2. Centrifuge for 1 minute at 2500 rpm; decant the supernatant.
3. Add zinc sulfate solution (specific gravity 1.18) until the tube is half full and resuspend the sediment with a wooden applicator stick.
4. Fill the tube to the top with more zinc sulfate solution.
5. Centrifuge the suspension for 1 minute at 2500 rpm. Do not apply the brake to the centrifuge or jar the tube, as either maneuver causes any eggs or cysts accumulated at the liquid–surface interface to sink.
6. Using a bacteriologic loop, remove two loopfuls of material from the surface and place them on a clean glass slide.
7. Examine under a microscope. (A small drop of Lugol’s iodine may be added to provide more contrast.)

The sugar (Sheather’s) flotation method is designed specifically for the recovery of *Cryptosporidium* sp. oocysts.

1. Filter stool through three pieces of cheesecloth.
2. Place 2 ml of stool filtrate in a conical tube.
3. Fill the tube to the top with sucrose solution.
4. Place a coverslip on top of the tube.
5. Centrifuge at 1000 rpm for 5 minutes. (If the stool sample is watery, no centrifugation is necessary.) Let the coverslip rest on the top of sucrose solution for 20 minutes.
6. Examine the coverslip under a microscope with magnification of 400 x. The focal plane is important because the oocysts are located on the inner surface of the coverslip, rather than on the slide itself.

The oocysts appear slightly pink in color without the addition of any stain. They are ovoid to spherical in shape, range in size from 5 to 6 μm in diameter and are usually not sporulated. There are no useful staining techniques.

**Blood**

Fresh, heparinized, or citrated blood samples are best for examination. Delays reduce the chances of finding the parasites.

Place a drop of blood on a slide, overlay with a coverslip, and examine under a microscope for living microfilariae or trypanosomes. Both groups of parasites are motile and can be seen swimming among the formed blood elements. Motility is significantly decreased if the blood
sample is refrigerated. If an organism is seen, the specimen should be stained, preferably with Giemsa solution.

**Urine**

**Gross Examination**
Observe and record the degree of turbidity and the color of the specimen.

**Microscopic Examination**
1. Take a drop of urine with a Pasteur pipette, preferably from the bottom of the container, and transfer it to a glass slide.
2. Examine under a microscope.

If searching for *Trichomonas vaginalis*, the specimen must be fresh (<1 hour old), because the trophozoites quickly lose their characteristic morphology and motility.

**Sedimentation by Centrifugation**
1. Divide the entire urine specimen into 15-ml conical glass centrifuge tubes.
2. Sediment at 1000 rpm for 5 minutes.
3. Discard the supernatant.
4. Resuspend the pellets with a Pasteur pipette and examine the material under a microscope.

**Sputum**

**Gross Examination**
Observe and record the appearance of the specimen.

**Microscopic Examination**
1. Transfer a small amount of sputum with a wooden applicator stick to a clean glass slide.
2. Add a drop of normal saline solution.
3. Examine under a microscope.

**Sedimentation by Centrifugation**
1. Mix sputum with equal parts of 3% NaOH.
2. Let stand 5 minutes.
3. Sediment at 1000 rpm for 5 minutes and examine under a microscope.

**Tissues**

Place a small piece (1–3 cu mm) of tissue between two clean glass slides using forceps, press to flatten, then examine under a microscope.

To examine skin scrapings, follow these steps:
1. Place the scrapings on a clean glass slide.
2. Add a drop of normal saline solution and overlay with a coverslip.
3. Let stand 30 minutes.
4. Press the coverslip gently to break up the skin pieces and then examine under a microscope.

Tapeworm proglottids must be carefully examined for a scolex. It is located at the narrowest end of the strobila. The scolex can adhere to toilet paper and must be sought there. The uterus in the proglottids is injected with India ink using a 25-gauge needle. A proglottid is then placed between two glass slides, compressed, and examined under the microscope to count the lateral branches on one side of the main uterine stem.

Arthropods are best identified preserved. The specimen should be placed in 70% ethanol and, when it is no longer motile, transferred to a Petri dish for examination.

**Aspirated Fluids**

**Sedimentation by Centrifugation**
1. Centrifuge clear fluid aspirates at 1000 rpm for 5 minutes in a conical centrifuge tube.
2. Decant supernatant.
3. Examine the pellet under a microscope.
4. Stain by the Wheatly-Gomori trichrome procedure.

**Miscellaneous Tests**

**Examination for Pinworms**
Clear tape preparations of various types, available commercially, are routinely used to look for pinworms. The tape is placed with the sticky side down on the perineum, and eggs or adult worms are thus picked up. The tape is then examined under a low-power lens of a microscope.
Adult pinworms are also occasionally found on the surface of formed stool samples.

**Preserved Specimens**

Whenever a delay of 24 hours or longer is anticipated, it is advisable to preserve the specimen. The preservative to be employed depends on the type of test selected.

**Stool**

**Direct Smear**

**Merthiolate-iodine-formaldehyde (MIF) Method**

A solution of merthiolate, iodine, and formaldehyde (MIF) preserves and stains trophozoites and cysts. The organisms develop an orange color. A permanent stain should also be done on the same stool sample. At present, there is no permanent staining procedure that can be carried out on an MIF-treated specimen. For example, if the Wheatly-Gomori trichrome stain is run on such a sample, the material peels off the coverslip.

1. Emulsify 1 g of stool sample in 10 ml of MIF solution.
2. Place a drop of stool–MIF emulsion on a clean glass slide and examine under a microscope.

Stools preserved in MIF can be concentrated by sedimentation using the formaldehyde-ether method (see above).

Stool specimens preserved in polyvinyl alcohol (PVA) can be stained by the Wheatly-Gomori trichrome solution in the same manner as described previously for unpreserved stool. The technique is the same as the one used on unpreserved stools except that Schaudinn’s fixative is not necessary and the staining time differs.

**Wheatly-Gomori Trichrome Stain for PVA-Pre­served Stool**

<table>
<thead>
<tr>
<th>Staining Solution</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol-iodine 70%</td>
<td>10–20 minutes</td>
</tr>
<tr>
<td>Ethanol 70%</td>
<td>3–5 minutes</td>
</tr>
<tr>
<td>Ethanol 70%</td>
<td>3–5 minutes</td>
</tr>
<tr>
<td>Trichrome stain</td>
<td>8–10 minutes</td>
</tr>
<tr>
<td>Ethanol 90% (acidified)</td>
<td>1–10 seconds</td>
</tr>
</tbody>
</table>

Dip the coverslip in the destaining solution once or twice. Rinse in 95% alcohol to stop the destaining process. Thin smears destain quickly; thicker smears require 3 to 5 dips.

<table>
<thead>
<tr>
<th>Destaining Solution</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol 95%</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Xylol</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

Mount the stained coverslip and examine it under a microscope.

**Blood**

**Microscopic Examination**

A thick smear consists of several drops of blood on a slide, dried in air, and hemolyzed by immersion in a hypotonic solution. This process concentrates the parasites. A thin smear is prepared by making a film of blood analogous to that used for a differential count of the white cells. Both must be stained by the Giemsa stain method.

1. Immerse the slide in 100% ethanol or methanol for 2–3 minutes.
2. Make a solution consisting of 1 drop of concentrated Giemsa stain per 1 ml of distilled water (pH 7.4) and fill a Copeland jar with 50 ml of the mixture.
3. Stain for 10-30 minutes.
4. Wash in distilled water.
5. Air-dry the slide.
6. Examine under an oil immersion lens of a microscope. View 100 fields of a thin smear.

**Concentration by Sedimentation**

The Knott technique concentrates and preserves microfilariae, which can be stained by the Giemsa solution and identified morphologically. The Knott Technique is as follows.

1. Mix 1 ml of heparinized blood with 9 ml of 2% formaldehyde.
2. Centrifuge at 2,000 rpm for 10 minutes.
3. Decant the supernatant.
4. Examine the sediment under a microscope.

If microfilariae are present, the material can then be stained as follows.

1. Spread the sediment on a clean glass slide.
2. Dry overnight.
3. Stain with Giemsa solution (1 ml of concentrated Giemsa stain in 50 ml of distilled water at pH 7.4).
4. Destain 10–15 minutes in water.
5. Air-dry.
6. Examine under a microscope.

Adjust the specific gravity to 1.18 by adding either more water or more zinc sulfate crystals.

**Solutions**

**Schaudinn’s Fixative**

HgCl₂, saturated aqueous solution: 666 ml (add 80 g HgCl₂ to 1 liter deionized water; stir 3–4 hours and then filter)

Ethyl alcohol 95%: 333 ml

Ethanol-iodine solution 70% (add enough crystalline iodine to 70% ethanol to turn the solution deep amber-brown; filter before using)

**Wheatly-Gomori Trichrome Stain**

Chromotrope 2R 0.6 g

Light green SF 0.3 g

Phosphotungstic acid 0.7 g

Mix with 1 ml of glacial acetic acid and stir gently for 20 minutes. Add 100 ml of distilled water, then store in dark brown bottle.

**Buffered Formaldehyde**

Formaldehyde solution 37–40% 100 ml

Sodium phosphate (monobasic, anhydrous) 4.0 g

Sodium phosphate (dibasic, anhydrous) 6.5 g

H₂O 900 ml

Adjust the pH of the solution to 7.0.

**Sugar Solution (Sheather’s Method)**

Sucrose 500 g

Water 320 ml

Phenol 6.5 g

**Merthiolate-Iodine-Formaldehyde Solution**

Tincture of Merthiolate No. 99 (Lilly) 1:1000 100 ml

Formaldehyde solution 37–40% 25 ml

Glycerol 5 ml

Water 250 ml

Store solution in a dark bottle.

**Lugol’s Iodine Solution**

Iodine 5 g

Potassium iodide 10 g

Water 100 ml

**Polyvinyl alcohol**

Polyvinyl alcohol is available commercially.

Schaudinn’s fixative 935 ml

Glycerol 15 ml

Glacial acetic acid 50 ml

Polyvinyl alcohol (powder) 50 g

Water 1000 ml

**Reference**

Appendix IV. Diagnostic Atlas of Nematodes, Cestodes, Trematodes, and Protozoa*

Nematodes

Figure A.1. Enterobius vermicularis. × 760.

Figure A.2. Trichuris trichiura. × 760.

Figure A.3. Ascaris lumbricoides (unfertilized). × 760.

Figure A.4. Ascaris lumbricoides (decorticated). × 760.

* Photographs by Dickson Despommier.
Figure A.5. Ascaris lumbricoides (fertilized). × 760.

Figure A.6. Hookworm. × 760.

Figure A.7. Capillaria hepatica. × 760.

Figure A.8. Capillaria philippinensis. × 760.

Figure A.9. Herterodera (plant nematode). × 480.

Figure A.10. Trichostrongylus sp. × 480.
Figure A.11. *Oesophagostomum* sp. × 480.

Figure A.12. *Dioctophyma renale*. × 760.

Figure A.13. *Gongylonema pulchrum*. × 760.

Figure A.14. *Brugia malayi*. × 600.

Figure A.15. *Mansonella ozzardi*. × 600.
Figure A.16. *Wuchereria bancrofti*. ×600.

Figure A.17. *Loa loa*. ×600.

Figure A.18. *Mansonella perstans*. ×600.

Figure A.19. *Dracunculus medinensis*. ×600.

Figure A.20. *Helicosporum* (plant artifact). ×600.
Cestodes

Figure A.21. *Taenia* sp. ×760.

Figure A.22. *Diphyllobothrium latum*. ×475.

Figure A.23. *Hymenolepis nana*. ×760.

Figure A.24. *Hymenolepis diminuta*. ×760.

Figure A.25. *Dipylidium caninum*. ×760.
Trematodes

Figure A.26. *Schistosoma mansoni*. ×340.

Figure A.27. *Schistosoma haematobium*. ×340.

Figure A.28. *Schistosoma japonicum* (Japan) Note small spine (arrow). ×340.

Figure A.29. *Schistosoma japonicum*. Some strains do not produce spined eggs. ×340.
Figure A.30. *Paragonimus westermani*. ×440.

Figure A.31. *Fasciola hepatica*. ×450.

Figure A.32. *Fasciolopsis buski*. ×450.

Figure A.33. *Echinostoma ilocanum*. ×450.

Figure A.34. *Clonorchis sinensis*. ×760.

Figure A.35. *Metagonimus yokogawai*. ×760.

Figure A.36. *Dicrocoelium dendriticum*. ×760.
Protozoa

**Figure A.37.** *Trichomonas tenax* (two trophozoites). $\times 1600.$

**Figure A.38.** *Trichomonas vaginalis* trophozoite. $\times 1200.$

**Figure A.39.** *Giardia lamblia* binucleate trophozoite. $\times 1000.$

**Figure A.40.** *Giardia lamblia* quadrinucleate cyst. $\times 1000.$
Figure A.41. *Chilomastix mesnili* trophozoite. × 1770.

Figure A.42. *Chilomastix mesnili* cyst. × 1500.

Figure A.43. *Retortamonas* sp. trophozoite. × 1000.

Figure A.44. *Dientamoeba fragilis* binucleate trophozoite. Note the nuclei (arrows). × 2200.

Figure A.45. *Entamoeba histolytica* trophozoite. *N*, nucleus; *RBC*, red blood cells. × 2800.

Figure A.46. *Entamoeba histolytica* trophozoite. *N*, nucleus. × 2800.
Figure A.47. *Entamoeba histolytica* trophozoite. ×2800.

Figure A.48. *Entamoeba histolytica* uninucleate cyst. C, chromatoidal bar. ×600.

Figure A.49. *Entamoeba histolytica* binucleate cyst. ×600.

Figure A.50. *Entamoeba histolytica* quadrinucleate cyst. C, chromatoidal bar. ×600.

Figure A.51. *Entamoeba histolytica* quadrinucleate cyst. Only three nuclei are visible in this view. ×600.

Figure A.52. *Entamoeba histolytica* quadrinucleate cyst. Same as in Figure A.51 but a different focal plane. One nucleus is visible in this view. ×600.
**Figure A.53.** Charcot-Leyden crystal. $\times 1400$.

**Figure A.54.** *Entamoeba coli* trophozoite. $\times 600$.

**Figure A.55.** *Entamoeba coli* octanucleate cyst. Three nuclei are visible in this view. $\times 500$.

**Figure A.56.** *Entamoeba coli* quadrinucleate cyst. Same as Figure A.55 but a different focal plane. Three nuclei are visible. $\times 500$.

**Figure A.57.** *Entamoeba coli* octanucleate cyst. Same as A.55 but a different focal plane. Two nuclei are visible in this view. $\times 500$.

**Figure A.58.** *Entamoeba coli* octanucleate cyst. Same as Figure A.55 but a different focal plane. Two nuclei are visible in this view. $\times 500$. 
Figure A.59. *Entamoeba coli* octanucleate cyst. Same as Figure A.55 but a different focal plane. Two nuclei are visible in this view. $\times 500$.

Figure A.60. *Entamoeba coli* octanucleate cyst. Same as Figure A.55 but a different focal plane. Two nuclei are visible in this view. $\times 500$.

Figure A.61. *Entamoeba hartmanni* trophozoite. $\times 1500$.

Figure A.62. *Entamoeba hartmanni* quadrinucleate cyst. $\times 1500$.

Figure A.63. *Iodamoeba beutschlii* trophozoite. $\times 1800$.

Figure A.64. *Iodamoeba beutschlii* cyst. $\times 1800$. 
Figure A.65. *Endolimax nana* (two trophozoites). $\times$1300.

Figure A.66. *Endolimax nana* quadrinucleate cyst. $\times$1300.

Figure A.67. *Entamoeba gingivalis* trophozoite. $\times$750.

Figure A.68. *Balantidium coli* trophozoite. $\times$600.

Figure A.69. *Balantidium coli* cyst. $\times$430.

Figure A.70. *Isospora* sp. unsporulated oocyst. $\times$900.
Figure A.71. *Isospora* sp. sporulated oocyst. ×1000.

Figure A.72. *Sarcocystis bovicanus* sporulated oocyst. ×800.

Figure A.73. *Cyclospora* sp. unsporulated oocyst. ×2600.

Figure A.74. *Microsporidia* sp. (arrows). ×1350.

Figure A.75. *Trypanosoma cruzi* trypomastigote. ×1500.
Figure A.76. *Trypanosoma brucei rhodesiense* trypomastigote. ×1500.

Figure A.77. *Babesia* sp. ×1750.
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