

Table 2 Histologic identification of parasites^a

Body site	Organisms	Stain ^b	Comments ^b
Tissue	Protozoa		
	<i>Entamoeba histolytica</i> (cecum, ascending colon, sigmoid rectal region; other sites less common); trophozoites and cysts are normally passed in stool	H&E, PAS, trichrome or iron hematoxylin in stool Figures 1 and 2	Differential between organism and histiocyte: in an organism, the nucleus may not be visible; in histiocytes, a portion of the nucleus is almost always visible; both trophozoites and histiocytes stain red with PAS (review nuclear details); histolysis of invaded tissue; flask-shaped ulcers; organisms seen in healthy ulcer margins, not in central, necrotic areas
	<i>Giardia lamblia</i> (duodenum); trophozoites and cysts are normally passed in stool; organisms can be seen in duodenal aspirates or using other sampling methods (Enterotest)	H&E, Giemsa, Loeffler's methylene blue; trichrome or iron hematoxylin in stool Figures 3 and 4	Normal to mild to severe blunting of villi; loss of the brush border; infiltration of lamina propria with lymphocytes and granulocytes; chronic inflammation; tissue invasion does not occur; trophozoites may appear as sagittal sections of small, crescentic organisms that may adhere to the epithelial surface; front views will reveal the typical teardrop shape
	<i>Balantidium coli</i> ; trophozoites and cysts are normally passed in stool; tissue invasion may occur in the colon and appendix	H&E, trichrome or iron hematoxylin in stool (may be difficult to see on permanent stained smears; wet mount is best)	Simple hyperemia to marked ulcerations (large intestine); very large size (trophozoites); presence of cilia, large cytostome, and prominent macronucleus will distinguish these ciliates from other protozoa; due to large size, cut

		Figure 5	planes may not reveal all internal morphology; early lesion resembles that of <i>E. histolytica</i> , but the opening into the mucosa is larger
	<i>Cryptosporidium</i> spp. (have been recovered from mouth to anus, more common in small intestine); oocysts (4–6 μm) are passed in stool; disseminated disease can occur, with oocysts being passed in sputum	H&E, modified acid-fast stains for stool (oocysts -positive) Figure 6	Mild to moderate villous atrophy, increased crypt size, mild to moderate mononuclear cell infiltrates of lamina propria; organisms along brush border are small and measure 3–5 μm; other coccidia and the microsporidia develop within the cells and so are not confused with the brush border location of <i>Cryptosporidium</i> spp.
	<i>Cyclospora cayetanensis</i>	H&E, modified acid-fast stains for stool (oocysts -positive, but staining variable) Figure 7	Developmental stages have been seen in jejunal enterocytes, usually at the luminal end rather than at the brush border; tends to resemble developmental stages of <i>I. belli</i>
	<i>Cystoisospora belli</i> (more common in small intestine); oocysts are passed in stool; unsporulated oocysts measure 20–33 μm long by 10–19 μm wide and may contain a single sporoblast (usually seen in cases of diarrhea)	H&E, modified acid-fast stains for stool (oocysts -positive) Figures 8 and 9	Same as <i>Cryptosporidium</i> spp., but development occurs within the epithelial cells; tissue eosinophilia can be seen
	Microsporidia; now classified with the fungi; identification of	H&E, tissue Gram stains, PAS, silver stains; modified	Developing spores seen within enterocytes; sizes of individual spores are ~1–3 μm in humans;

	organisms to the genus and species levels requires electron microscopy, tissue culture, immunofluorescence studies, or PCR; differentiation of spores from bacteria or small yeasts in stool is extremely difficult	trichrome and calcofluor white used for stool or urine Figures 10, 11, 12, 13, 14	<i>Enterocytozoon bieneusi</i> and <i>Encephalitozoon (Septata) intestinalis</i> involved, primarily seen in the compromised host; both organisms can disseminate to other organs and spores can be found in liver, lungs, kidneys, CNS, and cornea
	<i>Trypanosoma cruzi</i> (esophagus, colon); trypomastigote may be found in peripheral blood in the early stage of infection	H&E Figure 15.	Disease of ganglion cells of mesenteric plexuses; can cause severe distension and thinning of visceral wall; scarring, chronic inflammation; amastigotes may shrink, nuclei and kinetoplasts may not be visible in tissue sections and may resemble <i>Histoplasma</i> ; tissues most often involved include brain, cardiac, and smooth muscle cells
Nematodes			
	<i>Enterobius vermicularis</i> (cecum, appendix, other sites; may also be found in female reproductive tract or peritoneal cavity); eggs and adult worms recovered on Scotch tape preparations or pin-worm paddles; stool not recommended	H&E Figure 16	Characteristic lateral alae on worm cross sections; eggs in utero may also be visible; most often seen in appendix with little or no inflammation
	<i>Ascaris lumbricoides</i> (small intestine, bile ducts, liver, peritoneal	H&E Figure 17	Large size, characteristic muscular wall formed by long, irregular muscle fibers;

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	cavity); fertilized and unfertilized eggs passed in stool; adult worms may also be seen in stool; migrating larvae may be seen in sputum		sectioned (eggs may be seen with their thick, bumpy shells); the body wall has a thick, multilayered cuticle, fibrous-appearing hypodermis (expands to form large lateral chords, within which are seen excretory canals); short, muscular esophagus and simple intestinal tube with an irregular lumen; larval forms may be more difficult to identify
	<i>Strongyloides stercoralis</i> (usually duodenum and upper jejunum; may be in any tissue in disseminated disease); rhabditiform (noninfectious) larvae usually seen in stool; filariform (infectious) larvae, as well as adult worms and eggs, may be seen in stool in hyperinfection cases	H&E, Giemsa Figure 18, 19	Sections may reveal adult females, well-segmented eggs, and numerous larvae; although the morphology of the adult female may be difficult to see in tissues, the small size of the worm and the presence of developing eggs and larvae close to the adult worm strongly suggest this diagnosis; with hyperinfection, the bowel lining becomes congested and edematous, with possible ulcerations; chronic infection may reveal bowel wall fibrosis
	Hookworms (<i>Necator</i> , <i>Ancylostoma</i>) (usually upper part of small intestine); hookworm eggs normally passed in stool; eggs of both genera look the same	H&E Figure 20	Relatively thick cuticle and thin hypodermis; lateral hypodermal chords are usually visible; wide-open mouth sucking the mucosa; adult <i>Necator</i> has cutting plates, while <i>Ancylostoma</i> has teeth
	<i>Trichuris trichiura</i> (large intestine); whipworm eggs	H&E Figure 21	Most sections reveal both the thicker body area (“whip handle”), which lies free in the

	normally passed in stool		lumen, and the slender anterior area (“whip”), which is firmly embedded into the mucosa; sectioned eggs may be visible
	<i>Trichinella spp.</i> (muscle, GI)	H&E, PAS Figure 22	Edema, chronic inflammation, hyperemia, serosa petechiae, dilatation of bowel loops; prominent Peyer’s patches; swollen intestinal villi, mucin secretion; diffuse infiltration of eosinophils (lamina propria); larvae may be seen and may resemble microfilariae
Cestodes			
	<i>Taenia saginata</i> (most common), <i>T. solium</i> , <i>Diphyllobothrium latum</i> ; proglottids and/or eggs are normally passed in the stool	H&E, carmine Figure 23	May see loose proglottids and/or eggs in appendix
	<i>Hymenolepis nana</i> ; eggs are normally passed in the stool	H&E Figures 24, 25	Both larval and adult forms may be in intestinal sections in the human
	<i>Echinococcus granulosus</i> (mesentery)	H&E, acid fast, Ryan blue modified trichrome Figures 26, 27, 28 ,	External laminated, anuclear cyst wall; hooklets are acid fast
Trematodes			
	<i>Schistosoma mansoni</i> , <i>S. japonicum</i> , <i>S. haematobium</i> , less	H&E, acid fast Figures 29, 30, 31, 32	Adults and eggs may be seen in the mesentery or mesenteric veins; egg identification may

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	common schistosomes (<i>S. mekongi</i> , <i>S. intercalatum</i>); eggs may be seen in urine and/or stool		depend on demonstration of spine in section; important to determine if egg contains miracidium larva (indicates active infection); in the wall of the intestinal tract, polyp formation may occur (more eggs found in polyps); egg capsule of <i>S. mansoni</i> and miracidium larva of <i>S. haematobium</i> (if capsule intact) will stain positive acid-fast
Other Miscellaneous Parasites in Various Body Sites.			
	<i>Leishmania donovani</i> Blood parasites - protozoa in liver	H&E, PAS, Giemsa Figures 33, 34	Organisms are dot-like in routine section; they are larger (2–4 μm) in tissue impression smear; kinetoplast next to nucleus is very characteristic and differentiates these organisms from <i>Toxoplasma</i> (no kinetoplast); <i>Histoplasma</i> is PAS positive, while <i>L. donovani</i> is PAS negative
	<i>Toxoplasma gondii</i>	H&E, PAS Figure 35	Resting forms (bradyzoites) are pyriform with no kinetoplast (if many organisms are seen per cyst, they may appear as dots); bradyzoites within cysts are PAS positive; tissue cysts have a very thin wall; tissue cysts of <i>Toxoplasma</i> must be differentiated from <i>Sarcocystis</i> (seen most frequently in skeletal or cardiac muscle and larger than <i>Toxoplasma</i>); when reviewing animal tissues (from

			dogs), <i>Neospora caninum</i> may be present and will mimic <i>Toxoplasma</i>
Microsporidia		See intestine	See information on intestine
	<i>Plasmodium falciparum</i> , <i>P. vivax</i> , <i>P. malariae</i> , <i>P. ovale</i>	H&E	Exoerythrocytic stages (mature tissue schizonts) measure 45–80 µm and contain 15,000–40,000 merozoites per cell; malarial pigment may be seen in Kupffer cells; capillaries may be filled with parasitized RBCs (pigment is also visible here); the host does not respond to the presence of these organisms; pigment within blood vessels can be seen with routine tissue stains, but the use of polarized light may also be helpful in demonstrating the birefringent granules of malarial pigment
Nematodes			
	<i>Capillaria hepatica</i> ; eggs in human stool would be from the ingestion of parasitized livers, probably from squirrels or other animals (spurious infections—eggs disappear from the feces in a few days)	H&E, trichrome (Masson)	Liver parenchyma; eggs remain in liver and the life cycle does not continue in humans; eggs resemble those of <i>T. trichiura</i> , but the shell appears beaded or pitted; polar plugs are less pronounced than in <i>T. trichiura</i> ; intense granulomatous reaction around eggs; the general egg shape, the bipolar plugs, and striations in the thick shell make this identification relatively easy
	<i>Toxocara cati</i> or <i>T. canis</i> , <i>Baylisascaris</i> spp. (visceral larva migrans); adult worms	H&E	Liver contains largest number of larvae; any organ can be affected; eosinophilic granuloma; focal necrosis may

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	play no role in human disease (very rare exceptions)		occur; larval morphology includes single lateral ala, nonpatent intestine, and large paired excretory columns; <i>Baylisascaris</i> larvae are larger than <i>Toxocara</i> larvae and have a patent gut and a predilection for the CNS
Cestodes			
	<i>Echinococcus granulosus</i> ; adult worms and/or eggs found only in the small intestine of canids (primarily dogs)	H&E, acid fast, GMS, PAS	External laminated, anuclear cyst wall; thin nucleated inner layer; hooklets are acid fast; calcified cysts often reveal no hooklets; mature cysts contain brood capsules and protoscolices; degeneration of brood capsules results in “hydatid sand” (degenerating protoscolices and hooklets in the cyst fluid); some cysts are sterile
	<i>Echinococcus multilocularis</i> ; adult worms and/or eggs found only in the small intestine of canids (primarily dogs and foxes)	H&E, acid fast, GMS, PAS	Alveolar structure with no limiting membrane; scolices seldom present, thus no protoscolices, hooklets, or calcareous corpuscles; laminated and germinal layers are collapsed, folded, and scattered throughout the liver
Trematodes			
	<i>Schistosoma mansoni</i> , <i>S. japonicum</i> , <i>S. haematobium</i> , less common schistosomes (<i>S. mekongi</i> , <i>S. intercalatum</i>); eggs normally passed in urine and/or stool	H&E, trichrome (Masson)	Granulomatous tissue reaction around eggs (lymphocytes, plasma cells, eosinophils); trichrome demonstrates fibrotic tissue; eggs of <i>S. japonicum</i> more numerous in liver (greater egg-laying capacity); adult worms seen most frequently in

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			cross or transverse sections within blood vessels in the wall of the intestine or in liver; often the female is seen in copula, surrounded by the larger male body
			(continued)
	<i>Fasciola hepatica</i> (bile duct); eggs normally passed in stool	H&E	Large size plus cross section of worm containing intestinal diverticula; eggs may also be seen but are usually collapsed or distorted
	<i>Clonorchis (Opisthorchis) sinensis</i> (bile duct); eggs normally passed in stool	H&E	May be eosinophilic infiltration and slight thickening of the duct wall; may progress to fibrosis, cirrhosis of liver, biliary obstruction, etc.; long, coiled uterus full of eggs may be seen; adult trematodes in bile ducts may suggest <i>C. sinensis</i> , <i>Opisthorchis</i> spp., <i>Dicrocoelium dendriticum</i> , and <i>Fasciola</i> spp.
Spleen Protozoa			
	<i>Leishmania donovani</i>	H&E, PAS	See information on liver
	<i>Plasmodium falciparum</i> , <i>P. vivax</i> , <i>P. malariae</i> , <i>P. ovale</i>	H&E	See information on liver
Gallbladder This organ is seldom invaded by parasites; occasionally, <i>Cryptosporidium</i> , <i>microsporidia</i> , <i>Clonorchis (Opisthorchis) sinensis</i> , <i>Ascaris lumbricoides</i> , and <i>Fasciola hepatica</i> are found; schistosome			Eggs and/or sections of adult trematodes may be seen; developmental stages of <i>Cryptosporidium</i> possible

eggs may also be found			
Kidney	Protozoa		
	Microsporidia	See intestine	See information on intestine
Urinary	Trematode bladder		
		H&E, acid fast	Seen within blood vessels, often near the bladder; early inflammation may progress to thickening, hyperplasia, fibrosis, and ulceration; carcinoma may be a complication; terminal egg spine may be visible; important to determine if egg contains miracidium; eggs may be distorted and collapsed; calcified eggs may also be seen; eggs are not acid fast, like those of <i>S. mansoni</i> and <i>S. japonicum</i> ; adult worms may be seen in copula within the blood vessels
Lungs	Protozoa		
	<i>Entamoeba histolytica</i>	H&E	Usually, extension of liver abscess in the right lower lobe; may occur elsewhere; nucleus is not always visible; should be area of histolysis around organisms
	<i>Toxoplasma gondii</i>	H&E	Cysts look like those in the liver; tachyzoites are crescent shaped, especially when released from the cells
	<i>Cryptosporidium</i> spp.	H&E	Organism morphology similar to that in intestine; organisms may

			be seen in sputum in disseminated disease
	Microsporidia	Tissue Gram stains, PAS, silver stains, H&E	Organism morphology similar to that in intestine; spores may be found in sputum
Nematodes			
	<i>Strongyloides stercoralis</i> , <i>Ascaris lumbricoides</i> , hookworm, <i>Toxocara</i> spp., <i>Wuchereria bancrofti</i> , <i>Brugia malayi</i> , <i>Dirofilaria immitis</i>	H&E	Migrating larvae (<i>Strongyloides</i> , <i>Ascaris</i> , hookworm, <i>Toxocara</i> spp.) may be seen; microfilariae (<i>Wuchereria</i>) may cause an eosinophilic granuloma (pneumonitis, alveolar hemorrhage, edema)
Trematodes			
	<i>Paragonimus westermani</i> , other <i>Paragonimus</i> spp.; eggs can be found in sputum and/or stool	H&E	Reaction by lung tissue isolates the worm in a thick, fibrous capsule containing hemorrhagic, purulent exudate and eggs; adults typically paired, surrounded by fibrous capsule; spines on tegument and typical eggs make the diagnosis relatively easy
Heart	Protozoa		
	<i>Entamoeba histolytica</i>	H&E, PAS	May be present; pericardial tamponade may occur
	<i>Trypanosoma cruzi</i>	H&E	Amastigotes are morphologically identical to those of <i>L. donovani</i> found in the macrophages of the reticuloendothelial system; inflammatory cell infiltrates, interstitial edema, and separation of myofibers

	<i>Toxoplasma gondii</i>	H&E	Cysts appear like those in liver (no kinetoplast as in amastigotes of <i>T. cruzi</i>)
	Microsporidia	See intestine	See information on intestine
	<i>Plasmodium falciparum</i> (most important), <i>P. vivax</i> , <i>P. malariae</i> , <i>P. ovale</i>	H&E	May be marked congestion of the capillaries; blocked with parasitized RBCs and malarial pigment; evidence of anoxia (cloudy swelling, fatty degeneration, myocardial infarcts) may be seen
Skeletal muscle Protozoa			
	<i>Sarcocystis</i> spp. (rare)	H&E, GMS	Cylindrical cysts (Miescher's tubes) formed (double outer membrane and transverse trabeculae separating the cyst into closed compartments packed with spores); silver stain will clearly reveal the external capsule and septa
	Microsporidia	PAS, AFB, GMS, H&E	Organisms in the genera <i>Pleistophora</i> , <i>Trachipleistophora</i> , and <i>Brachiola</i> can be found in muscle in compromised hosts (cases on record rare); atrophic and degenerating muscle fibers full of spores (<i>Pleistophora</i> in clusters of ~12 organisms); each cluster enclosed by enveloping membrane (pansporoblastic membrane); spores measure 2.8 by 3.4 μm
			(continued)

Nematode			
	<i>Trichinella spp.</i>	H&E	Diaphragm most commonly invaded; biopsy usually not performed until after day 17, when larvae present a typical, coiled appearance; old, calcified cysts may be difficult to recognize
Cestode			
	<i>Taenia solium</i> (cysticercosis)	H&E	May also occur in brain, eye, muscles, heart, liver, lungs, abdominal cavity; cyst is oval or round and contains one invaginated scolex with crown of hooklets and four suckers; larva is usually surrounded by tissue reaction capsule, which is wrinkled after tissue processing (very typical appearance, often diagnostic even without cross section of scolex); cysticercus has a dark-staining spiral canal and a scolex surrounded by a thin, lightly staining bladder wall; parenchymatous portion consists of the invaginated scolex with its spiral canal, four suckers, and an armed rostellum with hooks; surface of spiral canal is deeply folded; parenchyma is usually filled with calcareous corpuscles; racemose form of cysticercosis appears as multiple sections of bladder wall tegument (scolex and spiral canal not seen)
Skin and	Protozoa	H&E, GMS	See information on liver

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subcutaneous tissue			
• <i>Leishmania</i> spp.			
Nematodes			
	<i>Wuchereria bancrofti</i> , <i>Brugia malayi</i>	H&E	Adults in lymphatic vessels (may be diagnosed in tissue sections); microfilariae in blood
	<i>Loa loa</i>		Adults in subcutaneous tissue; microfilariae in blood
	<i>Onchocerca volvulus</i>		Adults in subcutaneous nodules or in loose connective tissues from deeper areas within the body; may be diagnosed in tissue sections (fibrous nodules); microfilariae in skin; accidental infections with animal species of <i>Onchocerca</i> may occur; key features of thick cuticle, transverse ridges, and striations in the middle layer of cuticle are helpful
	<i>Mansonella ozzardi</i> , <i>M. perstans</i> , <i>M. streptocerca</i> , <i>Dirofilaria</i> spp.		Adults in body cavities (abdominal, pleural) and pericardium; microfilariae in blood (<i>M. streptocerca</i> in skin)
	Hookworm larvae	H&E	Differentiate from <i>Strongyloides</i> spp. (not found in skin)
Cestodes			
	<i>Spirometra</i> spp. (sparganosis)	H&E	Larvae often invade subcutaneous tissues or muscles (in or about the eyes); acute inflammatory reaction,

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			which is more severe as larva dies and is absorbed; solid-bodied sparganum lacks suckers and surrounding bladder wall seen in other cysticerci
	<i>Sparganum proliferum</i>	H&E	Produces a more severe reaction with metastatic branching and spread throughout the tissues; no scolex seen
Arthropods			
	<i>Demodex folliculorum</i> (mite)	H&E	Invades hair follicles and sebaceous glands; may be chronic inflammatory cells around mites
	<i>Sarcoptes scabiei</i> (itch mite)	H&E	Superficial skin layer (never below epidermis); preferred site is interdigital spaces, may be elsewhere (heavy infestations, i.e., Norwegian scabies)
	<i>Tunga penetrans</i> (chigoe, sand flea)	H&E	Prefers toes; causes intense itching, even pain
Lymphatic vessels	Nematodes <i>Wuchereria bancrofti</i> , <i>Brugia malayi</i>	H&E	Damage ranges from inflammatory sensitization to elephantiasis (tissue hyperplasia)
Testes			
	Nematode <i>Wuchereria bancrofti</i>	H&E	Worms may be calcified and lymphatic vessel replaced by collagen tissue
Nervous	Protozoa		

system	<i>Naegleria fowleri</i> , <i>Acanthamoeba</i> spp., <i>Balamuthia mandrillaris</i> (leptomyxid ameba), <i>Sappinia diploidea</i>	H&E	Brain lesions demonstrate congestion or hemorrhages, marked cellular infiltration (mononuclear, polymorphonuclear), and abscess formation; trophozoites have large karyosome and no chromatin on nuclear membrane; may be difficult to differentiate <i>Acanthamoeba</i> from <i>Balamuthia</i>
	<i>Entamoeba histolytica</i>	H&E, PAS	Histolysis of invaded tissue; trophozoite nucleus may not always be visible
	Microsporidia, <i>Encephalitozoon</i> spp., <i>Vittaforma</i> spp., <i>Nosema</i> spp., <i>Brachiola</i> spp., <i>Trachipleistophora</i> spp., “ <i>Microsporidium</i> ” spp.	PAS, AFB, GMS	Spores range from 2 to 4 μm and have been found in cerebrospinal fluid; appearance in tissue similar to other body sites; eye infections reported with <i>Encephalitozoon</i> , <i>Vittaforma</i> , <i>Nosema</i> , and members of the catchall genus “ <i>Microsporidium</i> ”
			(continued)
	<i>Trypanosoma brucei gambiense</i> , <i>T. brucei rhodesiense</i>	H&E	May be no reactive changes around organisms (brain); undulating membrane may be difficult to see
	<i>Toxoplasma gondii</i>	H&E	See information on liver; there is no cyst formation in an early acute infection (central nervous system more commonly involved)
	<i>Plasmodium falciparum</i>	H&E	Congested blood vessels

			containing parasitized RBCs and malarial pigment
Nematodes			
	<i>Angiostrongylus cantonensis</i>	H&E	Produces eosinophilic meningoencephalitis; cross section of worm is characterized by high muscle fibers under the cuticle with two prominent cords; cellular infiltrates composed of eosinophils and mononuclear cells
	<i>Toxocara</i> spp.	H&E	Granulomas or necrotic areas within periretinal inflammatory membrane
Cestodes			
	<i>Taenia solium</i> (cysticercosis)	H&E	May induce fibrous encapsulation; pronounced cellular reaction may occur as larva begins to die
	<i>Echinococcus granulosus</i>	H&E	Wall is finely laminated and has affinity for either acidic or basic dyes
Trematodes			
	<i>Schistosoma japonicum</i>	H&E	Hyperemia of meninges overlying granulomas in brain
	<i>Paragonimus</i> spp. (any area of brain)	H&E	Cysts may contain eggs, cellular debris, Charcot-Leyden crystals, eosinophils, plasma cells, and lymphocytes; granulomas form around eggs
^a Not every body site or every parasite is included in this table.			

^b CNS, central nervous system; H&E, hematoxylin and eosin stain; GMS, Gomori methenamine-silver stain; PAS, periodic acid-Schiff; RBC, red blood cell; AFB, acid-fast bacillus.

Reference:

Garcia LS. 2016. *Diagnostic Medical Parasitology*, 6th Ed. ASM Press, Washington, D.C.