SECOND EDITION

PRACTICAL GUIDE TO

Diagnostic Parasitology

Lynne S. Garcia, M.S., MT(ASCP), CLS(NCA), F(AAM)
LSG & Associates, Santa Monica, California

ASM PRESS
Washington, DC
I dedicate the second edition of this practical guide to Robyn Shimizu. Robyn and I have worked together for many years, performing bench work, training students, presenting workshops and seminars, handling consults, performing studies, and preparing manuscripts for publication. A very special thanks to Robyn for her collaboration and support—it’s been quite an adventure, and we’re looking forward to continued collaboration.
Contents

Preface xvii
Acknowledgments xxi

SECTION 1 Philosophy and Approach to Diagnostic Parasitology 1

Why Perform This Type of Testing? 2
   Travel 2
   Population Movements 2
   Control Issues 2
   Global Warming 2
   Epidemiologic Considerations 3
   Compromised Patients 3
   Approach to Therapy 3

Who Should Perform Diagnostic Parasitology Testing? 3
   Laboratory Personnel 3
   Nonlaboratory Personnel 4

Where Should Diagnostic Parasitology Testing Be Performed? 4
   Inpatient Setting 4
   Outpatient or Referral Setting 5
   Decentralized Testing 5
   Physician Office Laboratories 5
   Over-the-Counter (Home Care) Testing 5
   Field Sites 5

What Factors Should Precipitate Testing? 5
   Travel and Residence History 5
   Immune Status of the Patient 6
   Clinical Symptoms 6
   Documented Previous Infection 6
   Contact with Infected Individuals 6
Potential Outbreak Testing  7
Occupational Testing  7
Therapeutic Failure  7
What Testing Should Be Performed?  7
Routine Tests  7
Special Testing  8
Other (Nonmicrobiological) Testing  8
What Factors Should Be Considered When Developing Test Menus?  8
Physical Plant  8
Client Base  9
Customer Requirements and Perceived Levels of Service  9
Personnel Availability and Level of Expertise  9
Equipment  9
Budget  10
Risk Management Issues Associated with STAT Testing  10
Primary Amebic Meningoencephalitis  10
Granulomatous Amebic Encephalitis and Amebic Keratitis  12
Request for Blood Films  13
Automated Instrumentation  14
Patient Information  14
Conventional Microscopy  15

SECTION 2  Parasite Classification and Relevant Body Sites  17
Protozoa (Intestinal)  18
   Amebae  18
   Flagellates  19
   Ciliates  19
   Coccidia  20
   Microsporidia  20
Protozoa (Other Body Sites)  20
   Amebae  20
   Flagellates  21
   Coccidia  21
   Microsporidia  21
Protozoa (Blood and Tissue)  21
   Sporozoa  21
   Flagellates  22
       Leishmaniae  22
       Trypanosomes  22
Nematodes (Intestinal)  23
Nematodes (Tissue)  23
Nematodes (Blood and Tissue)  23
Cestodes (Intestinal) 23
Cestodes (Tissue) 24
Trematodes (Intestinal) 24
Trematodes (Liver and Lungs) 24
Trematodes (Blood) 24
Pentastomids 25
Acanthocephala 25
Table 2.1 Classification of Human Parasites 27
Table 2.2 Cosmopolitan Distribution of Common Parasitic Infections 30
Table 2.3 Body Sites and Possible Parasites Recovered 31

SECTION 3 Collection Options 33
Safety 34
Collection of Fresh Stool Specimens 34
  Collection Method 35
  Number of Specimens To Be Collected 35
    Standard Approach 35
    Different Approaches 36
  Collection Times 37
  Posttherapy Collection 38
  Specimen Type, Stability, and Need for Preservation 38
Preservation of Stool Specimens 39
  Overview of Preservatives 39
    Formalin 40
    Sodium Acetate-Acetic Acid-Formalin (SAF) 41
    Schaudinn's Fluid 42
    Polyvinyl Alcohol (PVA) 43
    Modified PVA (Mercury Substitutes) 44
    Single-Vial Collection Systems (Other Than SAF) 45
    Quality Control for Preservatives 46
    Procedure Notes for Use of Preservatives (Stool Fixative Collection Vials) 47
    Procedure Limitations for Use of Preservatives (Stool Fixative Collection Vials) 47
Collection of Blood 48
  Collection and Processing 48
    STAT Test Requests and Risk Management Issues 48
Collection of Specimens from Other Body Sites 49
  Table 3.1 Fecal Specimens for Parasites: Options for Collection and Processing 51
  Table 3.2 Approaches to Stool Parasitology: Test Ordering 54
  Table 3.3 Preservatives and Procedures Commonly Used in Diagnostic Parasitology (Stool Specimens) 56
  Table 3.4 Advantages of Thin and Thick Blood Films 57
Table 3.5 Advantages and Disadvantages of Buffy Coat Films 57
Table 3.6 Potential Problems of Using EDTA Anticoagulant for the Preparation of Thin and Thick Blood Films 58
Table 3.7 Body Sites and Possible Parasites Recovered 60

SECTION 4 Specimen Test Options: Routine Diagnostic Methods and Body Sites 61

Ova and Parasite Examination of Stool Specimens 62

Other Diagnostic Methods for Stool Specimens 63
  Culture of Larval-Stage Nematodes 64
  Estimation of Worm Burdens through Egg Counts 64
  Hatching Test for Schistosome Eggs 65
  Screening Stool Samples for Recovery of a Tapeworm Scolex 65

Testing of Other Intestinal Tract Specimens 65
  Examination for Pinworm 66
  Sigmoidoscopy Material 66
  Duodenal Drainage Material 67
  Duodenal Capsule Technique (Entero-Test) 67

Urogenital Tract Specimens 68
  Sputum 68
  Aspirates 69
  Biopsy Specimens 69

Blood 70
  Thin Blood Films 70
  Thick Blood Films 71
  Blood Staining Methods 71
  Buffy Coat Films 72
  QBC Microhematocrit Centrifugation Method 72
  Knott Concentration 72
  Membrane Filtration Technique 72

Culture Methods 72

Animal Inoculation and Xenodiagnosis 73

Antibody and Antigen Detection 73
  Antibody Detection 73
  Antigen Detection and Nucleic Acid-Based Tests 75
  Intradermal Tests 75

Table 4.1 Body Site, Procedures and Specimens, Recommended Methods and Relevant Parasites, and Comments 78

Table 4.2 Serologic, Antigen, and Probe Tests Used in the Diagnosis of Parasitic Infections 86

SECTION 5 Specific Test Procedures and Algorithms 87

Microscopy 88
  CALIBRATION OF THE MICROSCOPE 88

Ova and Parasite Examination 91
CONTENTS

DIRECT WET FECAL SMEAR 91
SEDIMENTATION CONCENTRATION (Formalin-Ethyl Acetate) 98
FLOTATION CONCENTRATION (Zinc Sulfate) 103
PERMANENT STAINED SMEAR 108

Stains Used in the Permanent Stained Smear 110
TRICHROME STAIN (Wheatley’s Method) 110
IRON HEMATOXYLIN STAIN (Spencer-Monroe Method) 116
IRON HEMATOXYLIN STAIN (Tompkins-Miller Method) 121
MODIFIED IRON HEMATOXYLIN STAIN (Incorporating the Carbol Fuchsin Step) 123
POLYCHROME IV STAIN 125
CHLORAZOL BLACK E STAIN 125

Specialized Stains for Coccidia and Microsporidia 127
KINYOUN’S ACID-FAST STAIN (Cold Method) 127
MODIFIED ZIEHL-NEELSEN ACID-FAST STAIN (Hot Method) 131
CARBOL FUCHSIN NEGATIVE STAIN FOR CRYPTOSPORIDIUM (W. L. Current) 134
RAPID SAFRANIN METHOD FOR CRYPTOSPORIDIUM (D. Baxby) 134
RAPID SAFRANIN METHOD FOR CYCLOSPORA, USING A MICROWAVE OVEN (Govinda Visvesvara) 135
AUARAMINE O STAIN FOR COCCIDIA (Thomas Hänscheid) 135
MODIFIED TRICHROME STAIN FOR MICROSPORIDIA (Weber, Green Counterstain) 139
MODIFIED TRICHROME STAIN FOR MICROSPORIDIA (Ryan, Blue Counterstain) 142
MODIFIED TRICHROME STAIN FOR MICROSPORIDIA (Evelyn Kokoskin, Hot Method) 145

Fecal Immunoassays for Intestinal Protozoa 147
Entamoeba histolytica 147
Cryptosporidium spp. 148
Giardia lamblia 148

Kits under Development 148
Comments on the Performance of Fecal Immunoassays 148

Larval Nematode Culture 150
HARADA-MORI FILTER PAPER STRIP CULTURE 150
BAERMANN CONCENTRATION 153
AGAR PLATE CULTURE FOR STRONGYLOIDES STERCORALIS 155

Other Methods for Gastrointestinal Tract Specimens 159
EXAMINATION FOR PINWORM (Cellulose Tape Preparations) 159
SIGMOIDOSCOPY SPECIMENS (Direct Wet Smear) 161
SIGMOIDOSCOPY SPECIMENS (Permanent Stained Smear) 165
DUODENAL ASPIRATES 168

Methods for Urogenital Tract Specimens 170
RECEIPT OF DRY SMEARS 170
DIRECT SALINE MOUNT 171
PERMANENT STAINED SMEAR 173
URINE CONCENTRATION (Centrifugation) 176
URINE CONCENTRATION (Nuclepore Membrane Filter) 179
Preparation of Blood Films 182
  THIN BLOOD FILMS 182
  THICK BLOOD FILMS 184
  COMBINATION THICK-THIN BLOOD FILMS 186
  BUFFY COAT BLOOD FILMS 188
Blood Stains 189
  GIEMSA STAIN 189
Blood Concentration 193
  BUFFY COAT CONCENTRATION 193
  KNOTT CONCENTRATION 195
  MEMBRANE FILTRATION CONCENTRATION 196
  Algorithm 5.1 Procedure for Processing Fresh Stool for the O&P Examination 201
  Algorithm 5.2 Procedure for Processing Liquid Specimens for the O&P Examination 202
  Algorithm 5.3 Procedure for Processing Preserved Stool for the O&P Examination—Two-Vial Collection Kit 203
  Algorithm 5.4 Procedure for Processing SAF-Preserved Stool for the O&P Examination 204
  Algorithm 5.5 Use of Various Fixatives and Their Recommended Stains 205
  Algorithm 5.6 Ordering Algorithm for Laboratory Examination for Intestinal Parasites 206
  Algorithm 5.7 Procedure for Processing Blood Specimens for Examination 208
Table 5.1 Body Site, Specimen, and Recommended Stain(s) 209
Table 5.2 Approaches to Stool Parasitology: Test Ordering 214
Table 5.3 Laboratory Test Reports: Optional Comments 216
Table 5.4 Parasitemia Determined from Conventional Light Microscopy: Clinical Correlation 217

SECTION 6 Commonly Asked Questions about Diagnostic Parasitology 219
Stool Parasitology 220
  Specimen Collection 220
    Intestinal Tract 220
    Fixatives 221
  Specimen Processing 222
    O&P Exam 222
Diagnostic Methods 224
    Direct Wet Examinations 224
    Concentrations 224
    Permanent Stains 227
Stool Immunoassay Options 228
Organism Identification 231
  Protozoa 231
  Helminths 232
Reporting 234
  Organism Identification 234
  Quantitation 236
Proficiency Testing 237
  Wet Preparations 237
  Permanent Stained Smears 237
Tissues or Fluids 237
Blood 238
  Specimen Collection 238
  Specimen Processing 240
  Diagnostic Methods 241
  Organism Identification 246
  Reporting 248
  Proficiency Testing 249
  General Questions 250

SECTION 7  Parasite Identification 255
Protozoa 256
  Amebae (Intestinal) 256
    Entamoeba histolytica 256
    Entamoeba dispar 258
    Entamoeba hartmanni 260
    Entamoeba coli 262
    Entamoeba gingivalis, Entamoeba polecki 264
    Endolimax nana 266
    Iodamoeba bütschlii 268
    Blastocystis hominis 270
  Flagellates (Intestinal) 274
    Giardia lamblia 274
    Dientamoeba fragilis 276
    Chilomastix mesnili 278
    Pentatrichomonas hominis 280
    Enteromonas hominis, Retortamonas intestinalis 282
  Ciliates (Intestinal) 284
    Balantidium coli 284
  Coccidia (Intestinal) 288
    Cryptosporidium spp. 288
    Cyclospora cayetanensis 290
    Isospora (Cystoisospora) belli 292
  Microsporidia (Intestinal) 294
    Enterocytozoon bieneusi 294
    Encephalitozoon intestinalis, Encephalitozoon spp. 296
Sporozoa (Blood and Tissue) 300
  Plasmodium vivax 300
  Plasmodium falciparum 302
  Plasmodium malariae 304
CONTENTS

Plasmodium ovale 306
Babesia spp. 308
Toxoplasma gondii 310

Flagellates (Blood and Tissue) 316
Leishmania spp. 316
Trypanosoma brucei gambiense (West), T. brucei rhodesiense (East) 318
Trypanosoma cruzi 320

Amebae (Other Body Sites) 324
Naegleria fowleri 324
Acanthamoeba spp., Balamuthia mandrillaris, Sappinia diploidea 326

Flagellates (Other Body Sites) 328
Trichomonas vaginalis 328

Nematodes 330
Intestinal 330
Ascaris lumbricoides 330
Trichuris trichiura 332
Necator americanus, Ancylostoma duodenale (Hookworms) 334
Strongyloides stercoralis 336
Enterobius vermicularis 338

Tissue 340
Ancylostoma braziliense, Ancylostoma caninum (Dog and Cat Hookworms) 340
Toxocara canis, Toxocara cati (Dog and Cat Ascarid Worms) 342
Trichinella spiralis 344

Blood and Tissue 346
Filarial Worms 346

Cestodes 350
Intestinal 350
Taenia saginata 350
Taenia solium 352
Diphyllobothrium latum 354
Hymenolepis nana 356
Hymenolepis diminuta 358
Dipylidium caninum 360

Tissue 362
Echinococcus granulosus 362

Trematodes 364
Intestinal 364
Fasciolopsis buski 364
Liver and Lungs 366
Paragonimus westermani, Paragonimus mexicanus, Paragonimus kellicotti 366
Fasciola hepatica 368
Clonorchis sinensis (Opisthorchis sinensis) 370

Blood 372
Schistosoma spp. (S. mansoni, S. haematobium, S. japonicum, S. mekongi, S. intercalatum) 372
SECTION 8 Identification Aids 375
Tables 8.1 to 8.37 376–433
Identification Keys 8.1 to 8.4 435–438
Figures 8.1 to 8.3 439–443
Plates 8.1 to 8.4 445–448

Index 449
Preface

As we move into the 21st century, the field of diagnostic medical parasitology continues to see some dramatic changes, including newly recognized pathogens, the spread of familiar pathogens, successes and failures related to disease control, geographic and climate changes that support the spread of parasitic disease, new methodology, regulatory requirements that impact on diagnostic testing, and an overall review of the approach to and clinical relevance of this type of diagnostic testing on patient care within the managed care environment, as well as the world as a whole.

The second edition of the Practical Guide to Diagnostic Parasitology is organized to provide maximum help to the user, particularly from the bench use perspective. New aspects of the field have been addressed in these sections, and many new figures and plates have been added. Section 1 on the philosophy and approach to diagnostic parasitology has been expanded to include discussions on the possible impact of global warming, population movements, potential outbreak testing, the development of laboratory test menus, and the risk management issues related to STAT testing. The discussion of organism classification and relevant tables has been expanded to provide the user with current information related to changes in nomenclature and overall importance of the various parasite categories to human infection.

In Section 3, expanded information on stool specimen fixatives and testing options has been provided. This information is valuable for any laboratory reviewing collection and testing options related to fixative compatibility with the routine ova and parasite examination, as well as the newer fecal immunoassays. Although some fecal immunoassay reagents are now commercially available for Enterocytozoon bieneusi and Encephalitozoon intestinalis, they are not FDA approved; always check the literature from the relevant company to confirm the FDA status of any new product. The discussion on blood collection, including the pros and cons of current changes from finger stick blood to venipuncture, has been
greatly enhanced, particularly related to potential problems with blood parasite morphology and lag time issues. Additional tables serve to summarize much of this new information.

Additional tables and information have been added to Sections 4 and 5, including a number of new algorithms. Section 6 is one of the most important sections in the book, with extensive revisions related to the most commonly asked questions regarding diagnostic parasitology methods. Additional techniques have been included, as well as new information related to reporting results and the importance of report comments. This section format makes it easy for the reader to use the expanded information.

Section 7 has been greatly expanded; information on each organism has been formatted on facing pages for easy access and reference. Figures have also been expanded and updated. Section 8 on identification aids has been expanded with additional tables and new plates. All of the changes for this edition are based on the need for the readers to update their information related to diagnostic medical parasitology and specifically the issues mentioned below.

With continued emphasis on regulatory requirements related to chemical disposal and the use of mercury compounds, laboratories are being required to develop skills using substitute fixatives that are prepared without the use of mercury-based compounds. Although continued work with these substitute fixatives has not produced the exact same quality organism morphology, the more relevant question is whether the intestinal parasites can be identified by using these alternative fixatives. In most cases, organism identification is comparable; an example of a rare exception is one in which the number of organisms present is quite low. This is a prime example of a change where "different" has been acceptable and relevant, not necessarily "good" or "bad."

Many laboratories are reviewing all microbiological services, and some specific questions are being asked related to diagnostic parasitology options. Some of these questions include the following: what laboratories should be performing this type of testing, when should testing be performed, what tests should be performed, and what factors should be considered when developing test menus.

Laboratories are also reviewing specimen collection options, particularly as they relate to their geographic area and types of patients serviced. This kind of analysis is beneficial to all concerned, not only in helping laboratories to understand the specimen collection options, but how they relate to test orders, diagnostic testing, and results impacting patient care.

With changes in collection, testing, reporting, and interpretation options, it is critical to remember that this information needs to be shared with the laboratory’s client base, particularly if the test orders and results are to be used for the best-quality patient care. Although there are many ways to approach diagnostic parasitology testing, it is mandatory that the laboratory and user both understand the pros and cons of the methods selected. The use of different approaches to parasitology diagnostic testing is acceptable; however, the benefits and drawbacks must be thoroughly understood by all participants. There may be legitimate reasons why dif-
different approaches are used by different laboratories; however, cost containment must not be the sole factor in selecting methods.

Another consideration is the fact that not all clinical laboratories will continue to perform diagnostic parasitology testing. This may be due to financial considerations, lack of skilled personnel, etc. With increased emphasis on cross-trained individuals, the technical expertise required to identify these parasites by using routine microscopy may be lacking. Even with the use of molecular diagnostics, these tests are not capable of covering the entire spectrum of organisms that may be present as pathogens. However, as more of these methods become commercially available, the use of nonmicroscopic methods will increase in scope. Many laboratories now include both the ova and parasite examination and various fecal immunoassays on their routine test menus; on the basis of patient histories and symptoms, appropriate orders may focus on one or the other of these options. An important consideration in deciding whether to send out parasitology testing or maintain the testing in-house relates to STAT testing (collection, processing, testing, reporting of thick and thin blood films, and the examination of cerebrospinal fluid and other specimens for the presence of free-living amebae). These tests must be handled as STATs; the time required from collection to reporting must be considered prior to moving these procedures off-site.

Based on the many changes in clinical laboratories within the past few years and many years’ experience with teaching and diagnostic bench work, it is my hope that the information contained in this practical guide to diagnostic parasitology will provide some valuable information for the user. This guide is not designed to serve as a diagnostic parasitology text or to contain all possible diagnostic test options but to help the user make some sense of a field for which training has become almost nonexistent. I have included a section on commonly asked questions about diagnostic medical parasitology and hope that this discussion will be of practical value to the user; the answers to some of these questions are often difficult to find, even in a more comprehensive book. Again, let me emphasize that different approaches to laboratory work are not always “good” or “bad.” The key to success is making sure that the laboratory and clients both understand the pros and cons of each collection, testing, and reporting option and that educational information is provided for all clients on an ongoing basis. Two of the most important functions of the clinical laboratory in the future will be educational and consultative, particularly when laboratory services are within the microbiology area.

A final point is that infectious diseases, particularly parasitic infections, play a huge role in the overall world’s health and economy. As travel increases, we anticipate seeing many more people who will be infected with parasites that may not be endemic to the specific area where they live. Continued vector and disease control efforts will remain on the high-priority list, especially when seen within the context of global health. Hopefully, parasitologists, including those who have diagnostic skills, will be available to support these global initiatives.
I thank the hundreds of colleagues over the past years who have shared their thoughts and suggestions regarding this fascinating field of diagnostic parasitology. There are too many of you to name—you all know who you are and we all recognize the pitfalls, as well as the fun, in providing diagnostic services in this field of microbiology.

I also thank the many bench techs and microbiologists who have tackled this field over the last 30+ years, including those who attended workshops and seminars; your contributions to the growth and expansion of diagnostic parasitology have been significant. Discussions of questions asked, problems for resolution, and reviews of testing options have been invaluable in shaping our approach to diagnostics in this field. This type of interaction, including the many discussions with the UCLA microbiology staff in the parasitology area, helped all of us keep an open mind when reviewing options and possible new ways to approach the work.

Over the years, our association with many companies has also been extremely valuable in helping understand test development, test trials, and relevance of results to the ultimate user within the diagnostic laboratory. Again, these interactions have helped maintain some balance and perspective on new options and their relevance to improved patient care.

A challenge to all of us who are still actively working in this area of diagnostic microbiology: serve as a mentor to some of the young people entering the field of microbiology. The number of personnel trained in this field continues to decline. Until parasite morphology is no longer required for differentiation and diagnosis, skilled microscopists will remain valuable members of the microbiology team and mandatory for the practice of diagnostic medical parasitology.

I thank Sharon Belkin for the new illustrations; she is always capable of translating my verbal descriptions into clear and accurate depictions of the various organisms. This is a true art, and she brings considerable expertise to the process; pictures are always a tremendous addition to verbal descriptions.
I also thank members of the editorial staff of ASM Press, including Susan Birch, Jeff Holtmeier, and our copy editor, Yvonne Strong; they are outstanding professionals. Susan’s expertise always helps the authors “look good,” and I appreciate her collaboration not only as an editor but also as a friend and colleague.

Above all, my very special thanks go to my husband, John, for his love and support for this and other projects over the years. I could never have taken on these challenges without his help, understanding, and wonderful sense of humor.
Index

Acanthamoeba
  body sites, 31, 60
classification, 21, 27
culture, 73, 236
cysts, 326–327
identification, 12–13, 326–327, 390
STAT testing, 12–13
trophozoites, 326–327, 390
Acanthocephalans, 25, 29
African eye worm, see Loa loa
Agar plate culture, S. stercoralis, 155–159, 336
Air travel, 2
Algorithm
  fixes and recommended stains, 205
  laboratory exam for intestinal parasites, 206–207
  processing blood for examination, 208
  processing fresh stool for O&P exam, 201
  processing liquid specimen for O&P exam, 202
Amastigotes
  Leishmania, 193–195, 316–317, 322
  T. cruzi, 320–321, 323, 419
Amebae
  intestinal artifacts that mimic, 445
classification, 18–19, 27
identification, 256–273
identification aids, 377–382, 420–421, 439
identification key, 435
sigmoidoscopy material, 66
other body sites
  classification, 20–21, 27–28
  identification, 324–327
Amebiasis, 256–257
Amniotic fluid, 84
Ancylostoma
  body sites, 31, 60
classification, 23, 28
Ancylostoma braziliense
  adults, 340–341
eggs, 340–341, 396
identification, 340–341, 396, 426
larvae, 340–341, 396, 426
Ancylostoma caninum
  adults, 340–341
eggs, 340–341, 396
identification, 340–341, 396
larvae, 340–341, 396
Ancylostoma duodenale, see also Hookworms
  adults, 334–335, 392
classification, 23, 28
eggs, 334–335, 393, 425
identification, 334–335, 392–394, 425
larvae, 334–335, 392, 394
life span, 391
Angiostrongylus
  classification, 23, 28
identification, 396–397
Angiostrongylus cantonensis, 396
Angiostrongylus costaricensis, 397
Animal inoculation, 73
Anisakis
  classification, 28
identification, 397
Antibody detection, 73–75, 86
Antigen detection, 75, 86, 149–150
  rapid tests, 432
Armillifer, 25, 29
Arthropods, classification, 29
Artifacts, 445–448
Ascariasis, 330–331
Ascarid worms
  cat ascarid worms, 342–343
dog ascarid worms, 342–343
Ascaris lumbricoides
  adults, 330–331, 394
  body sites, 31, 60
Ascaris lumbricoides (continued)
classification, 23, 28
eggs, 330–331, 392–393, 425, 442–443, 446
identification, 330–331, 392–394, 425
identification key, 437
larvae, 330–331, 392, 394
life span, 391
sputum, 68
worm burden through egg counts, 64–65
Aspirates, 69
Auramine O stain, 135–138

Babesia
blood films, 71
body sites, 31, 60
classification, 22, 27
differentiation from Plasmodium, 247
identification, 308–309, 429
ring forms, 308–309
sporozoites, 308
trophozoites, 308–309
Babesiosis, 308–309
Baermann concentration, culture of larval-stage nematodes, 64, 153–155
Balamuthia mandrillaris
body sites, 31, 60
classification, 21, 27
cysts, 326–327, 390
identification, 326–327, 390
trophozoites, 326–327, 390
Balantidiasis, 284–285
Balantidium coli
body sites, 31, 60
classification, 19–20, 27
cysts, 284–285, 386, 422
identification, 284–285, 422
trophozoites, 284–285, 386, 422
Baylisascaris procyonis
body sites, 31, 60
classification, 23
eggs, 395
identification, 395
larvae, 395
serologic tests, 234
Bentonite flocculation test, 74, 86
BinaxNOW malaria test, 250, 252–253, 433
Biopsy specimen, 69–70
questions asked about, 237–238
Blastocystis hominis
body sites, 31, 60
central-body forms, 270–271, 273
classification, 27
identification, 270–271, 439
morphologic criteria, 382
test reports, 216, 235
trophozoites, 270–271, 439
Blood concentration, 193–198, 250
buffy coat concentration, 193–195
Knott concentration, 72, 195–196
membrane filtration concentration, 72, 196–198
QBC microhematocrit centrifugation method, 72
Blood films, 48, 208
combination thick-thin, preparation, 186–188, 243–245
proficiency testing, 249–250
quality control, 246
questions asked about, 240–246
stains, 71–72, 189–193
STAT testing, 13–16
thick, 70–71, 241, 413
advantages, 57, 241
disadvantages, 241–242
preparation, 184–186
preservation, 245–246
problems associated with, 242
thin, 70–71, 413
advantages, 57, 243
disadvantages, 243
preparation, 182–184, 242–243
problems associated with, 243–244
storage, 241
Blood specimen, 70
collection, 48–49, 238–240
organism identification, 246–248
parasites recovered from, 31, 60
processing, 208, 240–241
questions asked about, 238–254
rapid diagnostic procedures, 433
specimens and test options, 78–79, 209
stains, 208, 246
test reports, 248–249
Bone marrow
parasites recovered from, 31, 60
specimens and test options, 69, 79, 209
Bone marrow aspirates, 69
Brachyoloma classification, 21, 28
identification, 388, 424
Bradyzoites, T. gondii, 310–311
Bronchial washing, 69
Bronchoalveolar lavage fluid, 69
Brugia, classification, 23, 28
Brugia malayi
identification, 346–347, 399, 430
identification key, 438
microfilariae, 346–348
Brugia timori, identification, 346–347, 399
Budget, laboratory, 10
Buffey coat blood films, 70, 72
advantages and disadvantages, 57
preparation, 48, 188–189
Buffey coat concentration, 193–195
Calabar swelling, 348
Capillaria hepatica
classification, 28
Cryptosporidium (continued)
classification, 20, 27
duodenal aspirate, 168–170
duodenal drainage material, 67
fecal immunoassay, 56, 148, 228–231, 432
identification, 221, 288–289, 387, 423
oocysts, 288–289, 298, 387, 423
sigmoidoscopy material, 66
sporozoites, 288, 298
sputum, 68
stains, 134–135
test reports, 234–235

Culture
axenic, 73
larval-stage nematodes, 64, 150–159, see also Larval-stage nematodes, culture
methods, 72–73
xenic, 73

Cutaneous ulcers
parasites recovered from, 31, 60
specimens and test options, 80, 210

Cyclospora cayetanensis
body sites, 31, 60
classification, 20, 27
identification, 221, 290–291, 387, 423
oocysts, 290–291, 298, 423
sporozoites, 290–291
stains, 135

Cyclosporiasis, 290–291

Cyst(s)
Acanthamoeba, 326–327
B. coli, 284–285, 386, 422
B. mandrillaris, 326–327, 390
C. mesnili, 278–279, 286, 385, 422, 440
E. coli, 262–263, 272, 379–380, 421, 439
E. dispers, 258–259, 272, 379–380, 420
E. hartmanni, 260–261, 272, 379–380, 420, 439
E. histolytica, 256–257, 272, 379–380, 420, 439
E. hominis, 282–283, 385, 440
E. nana, 266–267, 273, 379–380, 421, 439
G. lamblia, 274–275, 286, 385, 421, 440
I. bütschlii, 268–269, 273, 379–380, 421, 439
intestinal amebae, 379–380, 382
intestinal flagellates, 385
N. fowleri, 324–325, 390
R. intestinalis, 282–283, 385, 440
S. diploidea, 326–327, 390
T. gondii, 310
T. spiralis, 344–345

Cysticerci
T. saginata, 350–351, 400
T. solium, 352–353, 400

Cysticercosis, 352–353

Decentralized testing, 5
Delafeld’s hematoxylin stain, 189, 250
Diagnostic parasitology testing
factors precipitating testing, 5–7
personnel performing tests, 3–4
reasons to test, 2–3
routine tests, 7–8
special tests, 8
test menu development, 8–10
test site, 4–5

Dicrocoelium dendriticum
eggs, 408
identification, 408
identification key, 437

Dicrocoelium hospes, identification, 408

Dientamoeba fragilis
body sites, 31, 60
classification, 19, 27
identification, 276–277, 422, 440
identification key, 436
trophozoites, 276–277, 287, 383, 422, 440

Dientamoebiasis, 276–277

Diff-Quick stains, 246

Diphyllobothriasis, 354–355

Diphyllobothrium
classification, 23–24, 28–29
identification, 402–404

Diphyllobothrium latum
adults, 354–355, 400–401
body sites, 31, 60
eggs, 354–355, 401, 426, 442, 447
identification, 354–355, 400–401, 426
identification key, 437
larvae, 354–355, 400
proglottids, 354–355, 401, 426
scolex, 355, 400, 426

Diplogonoporus, 28

Diphylidium caninum
adults, 360–361, 400–401
classification, 23, 28
eggs, 360–361, 401
identification, 360–361, 400–401
identification key, 436
larvae, 360–361
oncospheres, 361
proglottids, 360–361, 401
scolex, 361, 400

Direct fluorescent-antibody test, 75, 86, 229

Direct saline mount, urogenital tract specimen, 171–173

Direct wet smear
diagnostic characteristics for organisms in, 376
fecal specimen, 62, 91–96
questions asked about, 222–224
review, 96
proficiency testing, 237
sigmoidoscopy specimen, 161–165

Dirofilaria
adults, 397
classification, 23, 28
identification, 346–347, 349, 397
larvae, 397
Double diffusion test, 74
Dracunculus medinensis
adults, 349, 396
identification, 396
larvae, 396
Drug resistance, 7
malaria, 251
Duodenal aspirate, 69, 168–170, 230
Duodenal capsule technique, 67–68
Duodenal drainage material, 67, 238

Echinococcus
body sites, 31, 60
classification, 24, 28
Echinococcus granulosus
adults, 362–363, 427
eggs, 362–363, 402, 427
identification, 362–363, 402–404, 427
larvae, 403
oncospheres, 362–363
proglottids, 362–363
scolex, 362–363, 403
Echinococcus multilocularis
eggs, 402, 427
identification, 402–404, 427
larvae, 403
scolex, 403
Echinococcus oligarthrus, identification, 402–404
Echinococcus vogeli, identification, 402–404
Echinostoma, identification key, 437
Echinostoma ilocanum
classification, 29
eggs, 405
identification, 405
ECOFIX, 222
ECOSTAIN, 222
EDTA anticoagulant, 48, 208, 238, 240
potential problems, 58–59, 413
Egg(s)
A. braziliense, 340–341, 396
A. caninum, 340–341, 396
A. duodenale, 334–335, 393, 425
A. lumbricoides, 330–331, 392–393, 425, 442–443, 446
B. procyonis, 395
C. hepatica, 397
C. sinensis, 370–371, 407, 427, 442
D. caninum, 360–361, 401
D. dendriticum, 408
D. hospes, 408
D. latum, 354–355, 401, 426, 442, 447
E. granulosus, 362–363, 402, 427
E. ilocanum, 405
E. multilocularis, 402, 427
E. pancreaticum, 408
E. vermicularis, 338–339, 392–393, 425, 442
F. buski, 364–365, 405, 427, 443
F. hepatica, 368–369, 407, 427, 443
G. hominis, 406
H. diminuta, 358–359, 401, 427, 442
H. heterophyes, 405
H. nana, 356–357, 401, 427, 442, 446
helmint, 232–233, 436–437
artifacts that mimic, 446
size, 441–443
hookworm, 442
L. minor, 395
M. yokogawai, 406
Multiceps, 402
N. americanus, 334–335, 425
O. felineus, 407
O. viverrini, 407
Paragonimus, 366–367, 408–409, 428, 443
S. stercoralis, 336–337
schistosome, 68, 233, 372–373, 410–411, 443
hatching test, 65
T. canis, 342–343, 396, 426
T. cati, 342–343, 396, 426
T. saginata, 350–351, 401
T. solium, 352–353, 401
T. trichiura, 332–333, 392–393, 425, 442, 446
Taenia, 442
Trichostrongylus, 393, 442
Egg counts, 64–65
Elephantiasis, 346–348, 430
Encephalitis, Toxoplasma, 311
Encephalitozoon
body sites, 31, 60
classification, 21, 28
identification, 388, 424
Encephalitozoon intestinalis
classification, 20, 27
identification, 296–297
spores, 296–297
Endolimax nana, 232
body sites, 31, 60
cysts, 266–267, 273, 379–380, 421, 439
identification, 266–267, 421, 439
identification key, 435
trophozoites, 266–267, 273, 377–378, 421, 439
Entamoeba
body sites, 31, 60
classification, 27–28
Entamoeba coli
cysts, 262–263, 272, 379–380, 421, 439
identification, 262–263, 421, 439
identification key, 435
trophozoites, 262–263, 265, 272, 377–378, 421, 439
Entamoeba dispar
cysts, 258–259, 272, 379–380, 420
identification, 258–259, 420
test reports, 216
trophozoites, 258, 272, 377–378, 420
Entamoeba gingivalis
identification, 264–265, 381
sputum, 68
trophozoites, 265, 381
Entamoeba hartmanni
cysts, 260–261, 272, 379–380, 420, 439
identification, 232, 260–261, 420, 439
identification key, 435
trophozoites, 260–261, 272, 377–378, 420, 439
Entamoeba histolytica
antigen tests, 75, 86
body sites, 31, 60
culture, 73
cysts, 256–257, 272, 379–380, 420, 439
fecal immunoassay, 147, 228–231, 432
identification, 256–257, 420, 439
identification key, 435
sputum, 68–69
test reports, 216
trophozoites, 257, 272, 377–378, 420, 439
Entamoeba polecki
identification, 264–265, 381–382, 439
identification key, 435
Enteritis, eosinophilic, 341
Enterobiasis, 338–339
Enterobius vermicularis
adults, 338–339, 392
body sites, 31, 60
cellulose tape preparation, 159–161, 338
classification, 23, 28
eggs, 338–339, 392–393, 425, 442
examination for, 66
identification, 338–339, 392–394, 425
identification key, 437
life span, 391
Enterocytozoon
classification, 21, 28
identification, 388, 424
Enterocytozoon bieneusi
body sites, 31, 60
classification, 20, 27
identification, 294–295
spores, 294–295
Enteromonas hominis
classification, 19, 27
cysts, 282–283, 385, 440
identification, 282–283, 440
identification key, 436
trophozoites, 282–283, 384, 440
Entero-Test, 67–68
Enzyme immunoassay, 75, 86, 149, 229
Epidemiologic considerations, 3
Epimastigotes
*T. brucei gambiense*, 318–319
*T. brucei rhodesiense*, 318–319
*T. cruzi*, 320–321
Epithelial cells, 445
Eurytrema pancreaticum, identification, 408
Eye specimen
parasites recovered from, 31, 60
questions asked about, 238
specimens and test options, 81, 210
Fasciola hepatica
adults, 368–369
body sites, 31, 60
cercariae, 368–369
classification, 24, 29
eggs, 368–369, 407, 427, 443
identification, 368–369, 407, 427
identification key, 437
larvae, 368–369
metacercariae, 368–369
Fascioliasis, 368–369
Fasciolopiasis, 364–365
Fasciolopsis buski
adults, 364–365
body sites, 31, 60
cercariae, 364–365
classification, 24, 29
eggs, 364–365, 405, 427, 443
identification, 364–365, 405, 427
identification key, 437
larvae, 364–365
metacercariae, 364–365
Fecal concentration, 62, 96–98
commercial devices, 97–98
flotation method, 96–97, 224–226
zinc sulfate procedure, 97, 103–107, 225
questions asked about, 222–226
review, 107–108
sedimentation method, 96–97, 224–226
formalin-ethyl acetate procedure, 97–102
Fecal immunoassay, 75, 432
Cryptosporidium, 56, 148, 228–231, 432
direct fluorescent-antibody test, 82, 229
*E. histolytica*, 147, 228–231, 432
enzyme immunoassay, 82
*G. lamblia*, 56, 148, 228–231, 432
intestinal protozoa, 147–150
kits under development, 148
performance, 148–149
questions asked about, 228–231
rapid, lateral-flow cartridge, 85, 86
specimen used for, 39, 51–54
Fecal specimen, see also Stool specimen
direct wet smear, 91–96
questions asked about, 222–224
permanent stained smear, 108–127
fresh material, 109
PVA-preserved material, 109–110
review, 126–127
SAF-preserved material, 110
stains, 110–127
proficiency testing, 236–237
Field sites, diagnostic testing, 5
Field’s stain, 246
Fiery serpent, see *Dracunculus medinensis*

Filarial worms, see also *Microfilariae*
- adults, 346–347
- classification, 28
- identification, 346–349
- larvae, 346–347

Filariasis, 346–347

Fine-needle aspirates, 69

Fixatives, stool, 39–48, 56, 63, 66
- formalin, 40–41, 56, 221–222
- MIF, 56
- polyvinyl alcohol, 43–44, 56, 222
- modified (mercury substitutes), 44–45, 56
- procedure limitations, 47–48
- procedure notes, 47
- quality control, 46–47
- questions asked about, 221–222
- Schaudinn’s fluid, 42–43, 56
- single-vial collection systems, 45–46, 56
- sodium acetate-acetic acid-formalin (SAF), 41–42, 56

Flagellates
- blood and tissue
  - classification, 22, 27
  - identification, 316–323
- intestinal
  - classification, 19, 27
  - identification, 274–283
  - identification aids, 383–386, 421, 440
  - identification key, 436
- other body sites
  - classification, 21, 28
  - identification, 328–329
  - identification aids, 422, 440

Flotation method, fecal concentration, 96–97, 224–226
- zinc sulfate procedure, 97, 103–107, 225

Fluid specimen, questions asked about, 237–238

Flukes, see also *Trematodes*
- blood flukes, 428
- Chinese liver fluke, 427
- giant intestinal fluke, 364–365, 427
- lung fluke, 428
- sheep liver fluke, 427

Fluorescence microscopy, 149–150

Fluorescent-antibody test, 74

Formalin, 40–41, 56, 221–222
- safety, 222, 226

Formalin-ethyl acetate procedure, fecal concentration, 97–102

Gametocytes
- *P. falciparum*, 239, 248, 302–303, 313
- *P. malariae*, 304–305, 314
- *P. ovale*, 306–307, 315
- *P. vivax*, 300–301, 312

*Gastrodiscoides hominis*
- classification, 29
- eggs, 406

*Giardia lamblia*
- antigen tests, 75, 86
- body sites, 31, 60
- classification, 19, 27
- cysts, 274–275, 286, 385, 421, 440
- duodenal aspirate, 168–170
- duodenal drainage material, 67
- fecal immunooassay, 56, 148, 228–231, 432
- identification, 274–275, 421, 440
- identification key, 436
- nomenclature, 234
- sigmoidoscopy material, 66
- trophozoites, 67, 274–275, 286, 383, 421, 440

*Giardiasis*, 274–275

*Giemsa stain*, 72, 189–193, 245, 250, 414–416

Global warming, 2

*Gnathostoma spinigerum*
- adults, 397
- classification, 23, 28
- identification, 397
- larvae, 397

Granulomatous amebic encephalitis, 326–327

STAT testing, 12–13

Hanging groin, 347

Harada-Mori filter paper strip culture, larval nematodes, 64, 150–153

*Hartmanella*
- body sites, 31, 60
- classification, 27

Hatching test, schistosome eggs, 65

*Helminths*
- eggs, 232–233, 436–437
- size, 441–443
- identification, 232–234
- identification aids, 376, 425–428, 430–431
- identification key, 436–437
- serologic, antigen, and probe tests, 86

*Heterodera marioni*, 437

*Heterophyes heterophyes*
- body sites, 31, 60
- classification, 24, 29
- eggs, 405
- identification, 405
- identification key, 436

*Histoplasma capsulatum*, 72, 448

Home care testing, 5

Hookworms, see also *Ancylostoma duodenale; Necator americanus*
- body sites, 31, 60
- cat hookworm, 340–341
- culture of larval stage, 64, 150–153
- dog hookworm, 340–341
- eggs, 442
- artifacts that mimic, 446
- identification, 334–335
- identification aids, 392–394
Hookworms (continued)
identification key, 437
life span, 391
sputum, 68
worm burden through egg counts, 64–65

Human cells, 448
Hydatid cyst, 362–363, 427
Hydatid disease, 75, 362–363, 402–404
Hydatid sand, 362–363

Hymenolepis diminuta
adults, 358–359, 400–401
body sites, 31, 60
classification, 23, 28
eggs, 358–359, 401, 427, 442
identification, 358–359, 400–401, 427
identification key, 436
larvae, 358–359
proglottids, 358–359
scolex, 359, 400

Hymenolepis nana
adults, 356–357, 400–401
body sites, 31, 60
classification, 23, 28
eggs, 356–357, 401, 427, 446
identification, 356–357, 400–401, 427
identification key, 436
larvae, 356–357
proglottids, 356–357
scolex, 356–357, 400

Hypnozoites
P. ovale, 429
P. vivax, 300, 429

Hysterohylacium, 28

Identification of parasites, 255–373
identification aids, 375–448
questions asked about, 231–234, 246–248

Immune status of patient, 6

Immunoblot, 86

Immunoelectrophoresis, 74

Indirect fluorescent-antibody test, 74–75, 86

Indirect hemagglutination test, 74

Inpatient setting, diagnostic testing, 4

International travel, 2, 5–6, 14–16

Intestinal tract
parasites recovered from, 31, 60
specimens and test options, 81–83, 211

Intradermal tests, 74–76

Iodamoeba bütschlii, 232
body sites, 31, 60
classification, 27
cysts, 268–269, 273, 379–380, 421, 439
identification, 268–269, 421, 439
identification key, 435
trophozoites, 268–269, 273, 377–378, 421, 439

Iron hematoxylin stain, 56
modified (carbol fuchsin step), 123–125
Spencer-Monroe method, 116–121

Tompkins-Miller method, 121–123

Isospora belli
body sites, 31, 60
classification, 20, 27
duodenal aspirate, 168–170
identification, 292–293, 387, 424
oocysts, 292–293, 299, 387, 424
sporozoites, 292–293, 387

Isosporiasis, 292–293

Jewish housewives’ disease, 355

Kala azar, see Leishmaniasis, visceral
Katayama fever, 373
Keratitis, Acanthamoeba, 12–13, 326–327
Kinyoun’s acid-fast stain (cold method), 127–131
Knott concentration, 72, 195–196

Laboratory personnel, 3–4
availability and level of expertise, 9

Lagochilascaris minor
adults, 395
eggs, 395
identification, 395
larvae, 395

Larva migrans
cutaneous, 340–341, 396
ocular, 342–343
visceral, 342–343, 396

Larvae
A. braziliense, 340–341, 396, 426
A. caninum, 340–341, 396
A. cantonensis, 396
A. duodenale, 334–335, 392, 394
A. lumbricoides, 330–331, 392, 394
B. procyonis, 395
C. sinensis, 370–371
D. caninum, 360–361
D. latum, 354–355, 400
D. medinensis, 396
Dirofilaria, 397
E. granulosus, 403
E. multilocularis, 403
F. buski, 364–365
F. hepatica, 368–369
filarial worms, 346–347
G. spinigerum, 397
H. diminuta, 358–359
H. nana, 356–357
L. minor, 395
Multiceps, 403
N. americanus, 334–335, 392–394

Paragonimus, 366–367
S. stercoralis, 336–337, 392–393, 425
schistosome, 372–373
T. canis, 342–343, 396, 426
T. cati, 342–343, 396, 426
T. saginata, 350–351
T. spiralis, 344–345, 395
Thelazia, 397
Trichostrongylus, 392, 394
Larval-stage nematodes, culture, 64, 150–159
agar plate culture, 155–159
Baermann concentration, 64, 153–155
charcoal culture, 64
Harada-Mori filter paper strip culture, 64, 150–153
petri dish filter paper culture, 64
review, 159
Lateral-flow cartridge, 150, 228
Latex agglutination test, 74, 86
Leishman-Donovan body, 316–317
Leishmania aethiopica, 418
Leishmania braziliensis, 418, 430
Leishmania donovani, 418, 430
amastigotes, 193–195
intradermal test, 75
Leishmania major, 418
Leishmania mexicana, 418
Leishmania tropica, 418
Leishmaniae
amastigotes, 316–317, 322
blood films, 71–72
body sites, 31, 60
bone marrow aspirate, 69
classification, 22, 27
culture, 73
identification, 316–317
identification aids, 418, 430
PCR test, 253
promastigotes, 316–317, 322
Leishmaniasis
cutaneous, 316–317, 322, 418, 429
dermal leishmanoid, 418
diffuse cutaneous, 418
mucocutaneous, 316–317, 322, 418, 429
visceral, 316–317, 322, 418, 429
Linguatula serrata, 25, 29
Liquid specimen, algorithm for O&P exam, 202
Liver abscess, 256–257
Liver and spleen
parasites recovered from, 31, 60
specimens and test options, 83, 211
Loa loa
body sites, 31, 60
classification, 23, 28
identification, 399, 431
identification key, 438
staining, 250
urine, 68
Microfilariae, 346–349
artifacts that mimic, 448
blood films, 70
body sites, 31, 60
identification aids, 399, 430–431
identification key, 438
staining, 250
urine, 68
Lungs, see Respiratory tract
Macracanthorhynchus hirudinaceus, 25, 29
Malaria, see also Plasmodium
“airport,” 14
blood films, 13–16, 71, 245–246
conventional microscopy, 15–16
blood specimen for diagnosis, 238–239
cerebral, 301, 303
characteristics of parasites, 429
drug resistance, 251
ovale, 306–307, 412, 429
patient history, 14–15
PCR test, 252
quartan, 304–305, 412, 429
rapid test, 250, 252–253, 433
serologic tests, 250–251
severity, 217, 249, 253
STAT testing, 13–16, 48–49
tertian, 300–301
benign tertian, 412, 429
malignant tertian, 302–303, 412, 429
test reports, 216, 248–249
Mansonella
classification, 23, 28
identification, 431
Mansonella ozzardi
identification, 346–347, 399
identification key, 438
microfilariae, 346–347, 349
Mansonella perstans
identification, 346–347, 399
identification key, 438
Mansonella streptocerca, identification, 346–347, 399, 430
Membrane filtration concentration
blood, 72, 196–198
urine, 179–181
Meningitis, eosinophilic, 395–396
Merozoites
P. falciparum, 302
P. malariae, 304, 429
P. ovale, 306, 429
P. vivax, 300, 429
Metacercariae
C. sinensis, 370–371
F. buski, 364–365
F. hepatica, 368–369
Paragonimus, 366–367
Metagonimus yokogawai
body sites, 31, 60
classification, 24, 29
eggs, 406
identification, 406
identification key, 436
Microfilariae, 346–349
artifacts that mimic, 448
blood films, 70
body sites, 31, 60
identification aids, 399, 430–431
identification key, 438
staining, 250
urine, 68
Microscope, calibration, 88–91
Microsporidia
  body sites, 31, 60
  identification, 221
  identification aids, 388–389, 424
intestinal
  classification, 20, 27
  identification, 294–297
  identification aids, 424
modified trichrome stains, 139–145
other body sites, classification, 21, 28
specimen processing for detection, 225–226
spores, 299, 424
sputum, 68
stains, 139–145, 389
Microsporidiosis, 294–297
Microsporidium
  classification, 21, 28
  identification, 388, 424
MIF, 56
Moniliformis moniliformis, 25, 29
Montenegro test, 75
Mosquito, Plasmodium infection, 253
Multiceps
  classification, 29
  eggs, 402
  identification, 402–404
  larvae, 403
  scolex, 403
Muscle
  parasites recovered from, 31, 60
  specimens and test options, 84, 211
Naegleria fowleri
  body sites, 31, 60
  classification, 21, 27
  culture, 73
cysts, 324–325, 390
  identification, 10–12, 324–325, 390
  STAT testing, 10–12
trophozoites, 324–325, 390
Nasopharynx, specimens and test options, 212
 Necator americanus, see also Hookworms
  adults, 334–335, 392
  classification, 28
  eggs, 334–335, 425
  identification, 334–335, 392–394, 425
  larvae, 334–335, 392–394
  life span, 391
Nematodes
  blood and tissue
    classification, 23, 28
    identification, 346–347
    identification aids, 425–426
intestinal
    classification, 23, 28
    cosmopolitan distribution, 30
    identification, 330–339
    identification aids, 392–394
    life spans, 391
    larval culture, 64, 150–159, see also Larval-stage nematodes, culture
    tissue
      classification, 23, 28
      cosmopolitan distribution, 30
      identification, 340–345
      identification aids, 395–397
    Neodiplostomum seoulense, 29
Nonmicrobiological testing, 8
Nosema
  classification, 21, 28
  identification, 424
Nucleic acid-based tests, 75, 86
Nucleopore membrane filter method, urine concentration, 179–181
Occupational testing, 7
"On Request" tests, 8
Onchocerca volvulus
  body sites, 31, 60
  classification, 23, 28
  identification, 346–347, 349, 399, 430
Onchocerciasis, 347
Oncospheres
  D. caninum, 361
  E. granulosus, 362–363
Oocysts
  C. cayetanensis, 290–291, 298, 423
  Cryptosporidium, 288–289, 298, 387, 423
  I. belli, 292–293, 299, 387, 424
  Sarcocystis, 387
Opisthorchis
  classification, 24, 29
  eggs, 407
  identification, 407
  Opisthorchis felineus, 407
  Opisthorchis viverrini, 407
Outbreak testing, 6–7
Outpatient setting, diagnostic testing, 5
Ova and parasite (O&P) examination algorithms, 201–204
  negative stool exam, 216
  questions asked about, 220–224
  specimen used for, 51–54
  stool specimen, 62–63
Over-the-counter testing, 5
PAM, see Primary amebic meningoencephalitis
Paragonimiasis, 366–367, 408–409
Paragonimus
  adults, 366–367
  body sites, 31, 60
cercariae, 366–367
  classification, 24, 29
  eggs, 366–367, 408–409, 428, 443
  identification, 366–367, 408–409
  identification key, 437
larvae, 366–367
metacercariae, 366–367
sputum, 68
Paragonimus africanus, 409
Paragonimus heterotremus, 409
Paragonimus hueitungensis, 366–367, 408–409
Paragonimus kellicotti, 366–367, 408–409
Paragonimus miyazakii, 409
Paragonimus ovata, 409
Paragonimus philippinensis, 409
Paragonimus skrjabini, 409
Paragonimus uterobilateralis, 409
Paragonimus westermani, 366–367, 408–409, 428, 443
Parasitemia, from light microscopy, 217
PCR tests, 75, 86
leishmaniasis, 253
malaria, 252
Pentastomids, classification, 25, 29
Pentatrichomonas hominis, 232
body sites, 31, 60
classification, 19, 27
identification, 280–281, 422, 440
identification key, 436
trophozoites, 280–281, 287, 384, 422, 440
Permanent stained smear, 62–63
diagnostic characteristics for organisms in, 376
fetal specimen, 108–127
fresh material, 109
PVA-preserved material, 109–110
review, 126–127
SAF-preserved material, 110
stains, 110–127
proficiency testing, 237
questions asked about, 222–228
sigmoidoscopy specimen, 165–167
urogenital tract specimen, 173–176
Petri dish filter paper culture, larval-stage nematodes, 64
Phaneropsolus bonnei, 29
Physician office laboratories, 5
Pinworm, see Enterobius vermicularis
Plagiochis, 29
Plasmodium, see also Malaria
artifacts that mimic, 447
body sites, 31, 60
bone marrow aspirates, 69
classification, 21–22, 27
differentiation from Babesia, 247
identification aids, 412, 414–417, 429
mosquitoes infected with, 253
test reports, 216
Plasmodium falciparum
drug resistance, 251
gametocytes, 248, 302–303, 313
Giems-stained thin blood smears, 414–416
identification, 238–239, 246–248, 302–303, 412, 429
merozoites, 302
rapid test, 433
ring form, 302–303, 313
sporozoites, 302
trophozoites, 302
Plasmodium knowlesi, 417
Plasmodium malariae
hematozoites, 304–305, 314
Giems-stained thin blood smears, 414–416
identification, 304–305, 412, 429
merozoites, 304, 429
sporozoites, 304–305
trophozoites, 304, 314
Plasmodium ovale
gametocytes, 306–307, 315
Giems-stained thin blood smears, 414–416
hypnozoites, 429
identification, 306–307, 412, 429
merozoites, 306, 429
sporozoites, 306
trophozoites, 306–307, 315
Plasmodium vivax
drug resistance, 251
gametocytes, 300–301, 312
Giems-stained thin blood smears, 414–416
hypnozoites, 300, 429
identification, 239, 300–301, 412, 429
merozoites, 300, 429
ring form, 300–301, 312
sporozoites, 300–301
trophozoites, 239, 300–301, 312
Pleistophora
classification, 21, 28
identification, 388, 424
Pneumocystis jiroveci, 68–69
Point-of-care testing, 5
Pollen, 446
Polyvinyl alcohol (PVA), 43–44, 56, 222
modified (mercury substitutes), 44–45, 56
Population movements, 2
Posttherapy specimen, 38
Preservatives, stool, see also Fixatives, stool
Previous infection, documented, 6
Primary amebic meningoencephalitis (PAM), 324–325
STAT testing, 10–12
Proficiency testing
blood films, 249–250
fetal specimens, 236–237
Proglottids
D. caninum, 360–361, 401
D. latum, 354–355, 401, 426
E. granulosus, 362–363
H. diminuta, 358–359
H. nana, 356–357
T. saginata, 350–351, 401, 426
T. solium, 352–353, 401, 426
Promastigotes, Leishmania, 316–317, 322
Prosthecodendrium molenkempi, 29
Protozoa

artifacts that mimic, 448

blood and tissue

classification, 21–22, 27

cosmopolitan distribution, 30

identification, 300–323

coccidia, identification, 288–293

intestinal

classification, 18–20, 27

cosmopolitan distribution, 30

fecal immunoassays, 147–150

identification, 231–232, 256–299

identification aids, 376–386, 420–424

test reports, 236

microsporidia, identification, 294–297

other body sites

classification, 20–21, 27–28

cosmopolitan distribution, 30

identification, 324–329

identification aids, 376, 420–424

PVA, see Polyvinyl alcohol

QBC microhematocrit centrifugation method, 72

Quality control

blood films, 246

stool fixatives, 46–47

Radioimmunoassay, 74

Rapid, lateral-flow cartridge, 86

Rapid blood stains, 189

Rapid diagnostic procedures, 432–433

Rapid safranin method

Cryptosporidium, 134–135

Cyclospora, 135

Schistosoma, 372–373

Scientific names, in test reports, 234

Scolex

D. caninum, 361, 400

D. latum, 355, 400, 426

E. granulosus, 362–363, 403

E. multilocularis, 403

H. diminuta, 359, 400

H. nana, 356–357, 400

Multiceps, 403

T. saginata, 350–351, 400, 426

T. solium, 353, 400, 426

tapeworm, screening stool samples for, 65

Sedimentation method, fecal concentration, 96–97, 224–226

formalin-ethyl acetate procedure, 97–102

Sebekia, 25, 29

Sheep-sheepdog disease, 362–363

Sinus cavities, specimens and test options, 212

Sodium acetate-acetic acid-formalin (SAF) fixative

Safety

formalin, 222, 226

specimen collection, 34

Sappinia diploidea

body sites, 31, 60

classification, 21, 27

cysts, 326–327, 390

identification, 326–327, 390

trophozoites, 326–327, 390

Sarcocystis

classification, 20, 27

identification, 387

oocysts, 387

trophozoites, 387

Schaudinn’s fluid, 42–43, 56

Schistosoma haematobium, 25, 29, 68, 411, 428, 443

Schistosoma intercalatum, 411

Schistosoma japonicum, 25, 29, 410, 428, 437, 443

Schistosoma mansoni, 24–25, 29, 410, 428, 437, 443

Schistosoma mekongi, 410

Schistosomes

adults, 372–373

body sites, 31, 60

cercariae, 372–373

classification, 24–25, 29

eggs, 68, 233, 372–373, 410–411, 443

hatching test, 65

identification, 372–373

identification aids, 410–411, 428

identification key, 437

larvae, 372–373

Schistosomiasis, 372–373

Scientific names, in test reports, 234

Scolex

D. caninum, 361, 400

D. latum, 355, 400, 426

E. granulosus, 362–363, 403

E. multilocularis, 403

H. diminuta, 359, 400

H. nana, 356–357, 400

Multiceps, 403

T. saginata, 350–351, 400, 426

T. solium, 353, 400, 426

tapeworm, screening stool samples for, 65

Sedimentation method, fecal concentration, 96–97, 224–226

formalin-ethyl acetate procedure, 97–102

Sebekia, 25, 29

Sheep-sheepdog disease, 362–363

Sinus cavities, specimens and test options, 212

Seeds, 448

Serologic tests, 73–75, 86

malaria, 250–251

trypanosomes, 253–254

Sigmoidoscopy material, 66

direct wet smear, 161–165

permanent stained smear, 165–167

Single-vial collection systems, 45–46, 56

Sodium acetate-acetic acid-formalin (SAF) fixative

INDEX

460

Downloaded from www.asmscience.org by
IP: 54.70.40.11
Skin
parasites recovered from, 31, 60
specimens and test options, 84, 213
Sodium acetate-acetic acid-formalin (SAF) fixative, 41–42, 56, 222
Sparganosis, 402–404
Special tests, 8
Specimen collection, 33–60
blood, 48–49
fresh stool, 34–39
safety, 34
stool specimen, 220–221
Spleen, see Liver and spleen
Spores
E. bieneusi, 294–295
E. intestinalis, 296–297
microsporidia, 299, 424
Sporozoa, blood and tissue
classification, 21–22, 27
identification, 300–315
Sporozoites
Babesia, 308
C. cayetanensis, 290–291
Cryptosporidium, 288, 298
I. belli, 292–293, 387
P. falciparum, 302
P. malariae, 304
P. ovale, 306
P. vivax, 300
T. gondii, 310
Sputum specimen, 68–69
Stains
auramine O stain, 135–138
blood films, 71–72, 189–193, 246
carbol fuchsin negative stain, 134
Chlorazol black E stain, 125–126
coccidia, 127–147
review, 138–139
Delafeld’s hematoxylin stain, 189, 250
Diff-Quick stains, 246
fecal specimen, 205
Field’s stain, 246
Giems stain, 72, 189–193, 245, 250, 414–416
iron hematoxylin stain, 56
modified (carbol fuchsin step), 123–125
Spencer-Monroe method, 116–121
Tompkins-Miller method, 121–123
Kinyoun’s acid-fast stain (cold method), 127–131
modified acid-fast stains (hot, cold), 127–138
review, 138–139
modified trichrome stain
microsporidia (Evelyn Kokoskin, hot method), 145–146
microsporidia (Ryan, blue counterstain), 142–145
microsporidia (Weber, green counterstain), 139–141
review, 146–147
permanent stained fecal smear, 110–127
polychrome IV stain, 56, 125
rapid blood stains, 209, 246
rapid safranin method
Cryptosporidium, 134–135
Cyclospora, 135
recommendations for suspect organisms, 209–213
trichrome stain, 56
Wheatley’s method, 110–116, 227
Wright’s stain, 71–72, 189, 246
Wright-Giemsa combination stain, 189
Ziehl-Neelsen acid-fast stain (hot method), 131–134
STAT requests, 4–5
CNS for free-living amebae, 4–5
malaria, 48–49
risk management issues, 10–16, 48–49
Stoll count, 65
Stool fixatives, 39–48, see also Fixatives, stool
Stool specimen, see also Fecal specimen
collection, 34–39, 220–221
collection method, 35
collection times, 37–38
different approaches, 36–37
number of specimens collected, 35
posttherapy, 38
fixatives and recommended stains, 205
fresh stool, algorithm for O&P exam, 201
liquid, algorithm for O&P exam, 202
O&P examination, 62–63
options for collection and processing, 51–54
preservation, 38–48
preserved, algorithm for O&P exam, 201
questions asked about, 220–224
rapid diagnostic procedures, 432
rejection, 51
specimen processing, 222–224
specimen type, 38–39
stability, 38–39
test options, 81–83, 211
Strongyloides stercoralis
adults, 336–337
body sites, 31, 60
classification, 23, 28
culture of larval stage, 64, 150–159
duodenal aspirate, 168–170
duodenal drainage material, 67
eggs, 336–337
hyperinfection syndrome, 336–337, 394
identification, 233–234, 336–337, 392–394, 425
larvae, 67, 233–234, 336–337, 392–393, 425
life span, 391
sputum, 68
Strongyloidiasis, 336–337
Tachyzoites, *T. gondii*, 310–311

*Taenia*
  - classification, 23, 28
  - eggs, 442, 446

*Taenia saginata*
  - adults, 350–351, 400–401
  - body sites, 31, 60
  - classification, 28
  - cysticerci, 350–351, 400, 426
  - eggs, 350–351, 401
  - identification, 350–351, 400–401, 426
  - identification key, 436
  - larvae, 350–351
  - proglottids, 350–351, 401
  - scolex, 350–351, 400, 426

*Taenia solium*
  - adult-onset epilepsy, 353
  - adults, 352–353, 400–401
  - body sites, 31, 60
  - classification, 24, 28
  - cysticerci, 352–353, 400
  - eggs, 352–353, 401
  - identification, 352–353, 400–401, 426
  - identification key, 436
  - proglottids, 352–353, 401, 426
  - scolex, 353, 400, 426

*Taeniasis*, 350–353

*Tapeworm*, see also *Cestodes*
  - beef tapeworm disease, 350–351, 426
  - broad fish tapeworm disease, 354–355, 426
  - dog and cat tapeworm disease, 360
  - dwarf tapeworm disease, 356–357, 427
  - pork tapeworm disease, 352–353, 426
  - rat tapeworm disease, 358–359, 427
  - scolex, screening stool samples for, 65

*Ternidens diminutus*, 28

Test menu, factors in development, 8–10
  - budget, 10
  - client base, 9
  - customer requirements and perceived level of service, 9
  - equipment, 9–10
  - personnel available, 9
  - physical plant, 8–9


Test procedures, 87–217

Test reports, 216
  - blood, 248–249
  - malaria, 248–249
  - organism identification, 234–236
  - quantitation, 236–237
  - questions asked about, 234–237

*Thelazia*
  - classification, 28
  - identification, 397

Therapeutic failure, 7

Therapeutic regimens, 3

*Thorny-headed worms*, see *Acanthocephalans*

*Threads*, 447

*Tissue specimen*, questions asked about, 237–238

*Tongue worms*, see *Pentastomids*, classification

*Toxocara*
  - body sites, 31, 60
  - classification, 23, 28

*Toxocara canis*
  - adults, 342–343
  - eggs, 342–343, 396, 426
  - identification, 342–343, 396, 426
  - larvae, 342–343, 396, 426

*Toxocara cati*
  - adults, 342–343
  - eggs, 342–343, 396, 426
  - identification, 342–343, 396, 426
  - larvae, 342–343, 396, 426

*Toxoplasma gondii*
  - body sites, 31, 60
  - bradyzoites, 310–311
  - classification, 28
  - culture, 73
  - cysts, 310
  - identification, 310–311
  - sporozoites, 310
  - tachyzoites, 310–311
  - trophozoites, 310

*Toxoplasmosis*, 310–311

*Trachipleistophora*
  - classification, 21, 28
  - identification, 388, 424

Travel history, 2, 5–6, 14–16

*Trichinella*
  - identification, 395
  - larvae, 395

*Trichinella spiralis*
  - adults, 344–345
  - body sites, 31, 60
  - classification, 23, 28
  - clinical conditions, 398
  - cysts, 344–345
  - identification, 344–345, 395, 398
  - larvae, 344–345, 395
  - life cycle stages, 398
Trichinosis, 344–345
Trichomonas tenax, 21, 28, 68–69, 280–281, 287, 384
Trichomonas vaginalis
  body sites, 31, 60
  classification, 21, 28
  culture, 73
  identification, 68, 328–329, 391, 422, 440
  nucleic acid-based probe test, 75
  trophozoites, 287, 328–329, 391, 422
  urogenital specimen
    direct saline mount, 171–173
    permanent stained smear, 173–176
Trichomoniasis, 328–329
Trichostrongylus
  classification, 23, 28
  culture of larval stage, 64, 150–153
  eggs, 393, 442
  identification, 392–394
  identification key, 437
  larvae, 392, 394
Trichrome stain, 56
  modified, 139–146
    microsporidia (Evelyn Kokoskin, hot method), 145–146
    microsporidia (Ryan, blue counterstain), 142–145
    microsporidia (Weber, green counterstain), 139–141
  review, 146–147
  questions asked about, 227–228
  Wheatley's method, 110–116, 227
Trichuriasis, 332–333
Trichuris trichiura
  adults, 332–333, 392
  body sites, 31, 60
  classification, 23, 28
  eggs, 332–333, 392–393, 425, 442, 446
  identification, 332–333, 392–394, 425
  identification key, 437
  life span, 391
  worm burden through egg counts, 64–65
Trophozoites
  Acanthamoeba
    326–327, 390
  B. coli
    284–285, 386, 422
  B. hominis
    270–271, 439
  B. mandrillaris
    326–327, 390
  Babesia
    308–309
  C. mesnili
    278–279, 286, 383, 422, 440
  D. fragilis
    276–277, 287, 383, 422, 440
  E. coli
    262–263, 265, 272, 377–378, 421, 439
  E. dispar
    258, 272, 377–378, 420
  E. gingivalis
    265, 381–382
  E. hartmanni
    260–261, 272, 377–378, 420, 439
  E. histolytica
    257, 272, 377–378, 420, 439
  E. hominis
    282–283, 384, 440
  E. nana
    266–267, 273, 377–378, 421, 439
  G. lamblia
    67, 274–275, 286, 383, 421, 440
  I. bütschlii
    268–269, 273, 377–378, 421, 439
  intestinal amebae, 377–378, 381
  intestinal flagellates, 383–384
  N. fowleri
    324–325, 390
  P. falciparum
    302
  P. hominis
    280–281, 287, 384, 422, 440
  P. malariae
    304, 314
  P. ovale
    306–307, 315
  P. vivax
    239, 300–301, 312
  R. intestinalis
    282–283, 384, 440
  S. diploidea
    326–327, 390
  Sarcocystis
    387
  T. gondii
    310
  T. vaginalis
    287, 328–329, 391, 422
Trypanosoma brucei gambiense
  classification, 22, 27
  epimastigotes, 318–319
  identification, 318–319, 419
  serologic test, 254
  trypomastigotes, 318–319, 323, 419
Trypanosoma brucei rhodesiense
  classification, 22, 27
  epimastigotes, 318–319
  identification, 318–319, 419
  serologic test, 253–254
  trypomastigotes, 318–319, 323, 419, 429
Trypanosoma cruzi
  amastigotes, 320–321, 323, 419
  body sites, 31, 60
  culture, 73
  epimastigotes, 320–321
  identification, 320–321, 419, 429
  trypomastigotes, 320–321, 323, 419, 429
  xenodiagnosis, 73, 323
Trypanosoma rangeli, 419
Trypanosomes
  blood films, 71
  body sites, 31, 60
  bone marrow aspirates, 69
  classification, 22, 27
  identification, 318–319
  identification aids, 419, 429–430
  serologic tests, 253–254
Trypanosomiasis
  African, 318–319, 419, 429–430
  American (Chagas' disease), 320–321, 419, 429
Trypomastigotes
  T. brucei gambiense, 318–319, 323
  T. brucei rhodesiense, 318–319, 323, 419, 429
  T. cruzi, 320–321, 323, 419, 429
UNIFIX (with PVA), TOTAL FIX (without PVA), 222
Urinary sediment, 68
Urine concentration
  centrifugation method, 176–179
  nucleopore membrane filter method, 179–181
Urogenital tract specimen, 68
  direct saline mount, 171–173
  dry smear, 170
  parasites recovered from, 31, 60
Urogenital tract specimen (continued)
   permanent stained smear, 173–176
   specimens and test options, 85, 213

Vittaforma
   classification, 21, 28
   identification, 388, 424

Wet mount, 4
   direct, see Direct wet smear
Whipworm, see Trichuris trichiura
White blood cells, 235
Whole blood, 48, 70
Winterbottom’s sign, 323, 419
Worm burden, estimation through egg counts, 64–65
   Beaver method, 64–65
Wright’s Dip Stat Stain, 246

Wright’s stain, 71–72, 189, 246
Wright-Giemsa combination stain, 189
Wuchereria bancrofti
   classification, 23, 28
   identification, 346–347, 399, 430
   identification key, 438
   microfilariae, 346–348

Xenodiagnosis, 73, 323
Xylene, 228
Xylene substitutes, 228

Yeast, 235, 448

Ziehl-Neelsen acid-fast stain (hot method), 131–134
Zinc sulfate procedure, fecal concentration, 97, 103–107, 225
Z-PVA, 222