TABLE 248-1 CHARACTERISTICS OF *PLASMODIUM* SPECIES INFECTING HUMANS

Characteristic	Finding for Indicated Species[a]			
	P. falciparum	*P. vivax*	*P. ovale*	*P. malariae*
Duration of intrahepatic phase (days)	5.5	8	9	15
Number of merozoites released per infected hepatocyte	30,000	10,000	15,000	15,000
Duration of erythrocytic cycle (hours)	48	48	50	72
Red cell preference	Younger cells (but can invade cells of all ages)	Reticulocytes and cells up to 2 weeks old	Reticulocytes	Older cells
Morphology	Usually only ring forms[b]; banana-shaped gametocytes	Irregularly shaped large rings and trophozoites; enlarged erythrocytes; Schüffner's dots	Infected erythrocytes, enlarged and oval with tufted ends; Schüffner's dots	Band or rectangular forms of trophozoites common
Pigment color	Black	Yellow-brown	Dark brown	Brown-black
Ability to cause relapses	No	Yes	Yes	No

[a]In Southeast Asia, the monkey malaria parasite *P. knowlesi* also causes disease in humans. Young ring forms resemble those of *P. falciparum*, while older trophozoites resemble those of *P. malariae*. Reliable identification requires molecular genotyping. [b]Parasitemias of >2% are suggestive of *P. falciparum* infection.

by falciparum malaria, *P. knowlesi* and occasionally *P. vivax* also can cause severe illness. Human infection begins when a female anopheline mosquito inoculates plasmodial *sporozoites* from its salivary gland during a blood meal (Fig. 248-1). These microscopic motile forms of the malaria parasite are carried rapidly via the bloodstream to the liver, where they invade hepatic parenchymal cells and begin a period of asexual reproduction. By this amplification process (known as *intrahepatic* or *preerythrocytic schizogony* or *merogony*), a single sporozoite eventually may produce from 10,000 to >30,000 daughter merozoites. The swollen infected liver cells eventually burst, discharging motile *merozoites* into the bloodstream. These merozoites then invade the red blood cells (RBCs) and multiply six- to twentyfold every 48 h (*P. knowlesi*, 24 h; *P. malariae*, 72 h). When the parasites reach densities of ~50/μL of blood (~100 million parasites in the blood of an adult), the symptomatic stage of the infection begins. In *P. vivax* and *P. ovale* infections, a proportion of the intrahepatic forms do not divide immediately but remain inert for a period ranging from 3 weeks to ≥1 year before reproduction begins. These dormant forms, or *hypnozoites*, are the cause of the relapses that characterize infection with these two species.

After entry into the bloodstream, merozoites rapidly invade erythrocytes and become *trophozoites*. Attachment is mediated via a specific erythrocyte surface receptor. For *P. falciparum*, the reticulocyte-binding protein homologue 5 (PfRh5) is indispensable for erythrocyte invasion. Basigin (CD147, EMMPRIN) is the erythrocyte receptor of PfRh5. In the case of *P. vivax*, this receptor is related to the Duffy blood-group antigen Fy^a or Fy^b. Most West Africans and people with origins in that region carry the Duffy-negative FyFy phenotype and are therefore resistant to *P. vivax* malaria. During the early stage of intraerythrocytic development, the small "ring forms" of the different parasitic species appear similar under light microscopy. As the trophozoites enlarge, species-specific characteristics become evident, pigment becomes visible, and the parasite assumes an irregular or ameboid shape. By the end of the intraerythrocytic life cycle, the parasite has consumed two-thirds of the RBC's hemoglobin and has grown to occupy most of the cell. It is now called a *schizont*. Multiple nuclear divisions have taken place (*schizogony* or *merogony*). The RBC then ruptures to release 6–30 daughter merozoites, each potentially capable of invading a new RBC and repeating the cycle. The disease in human beings is caused by the direct effects of the asexual parasite—RBC invasion and destruction—and by the host's reaction. After release from the liver (*P. vivax*, *P. ovale*, *P. malariae*, *P. knowlesi*), some of the blood-stage parasites develop into morphologically distinct,

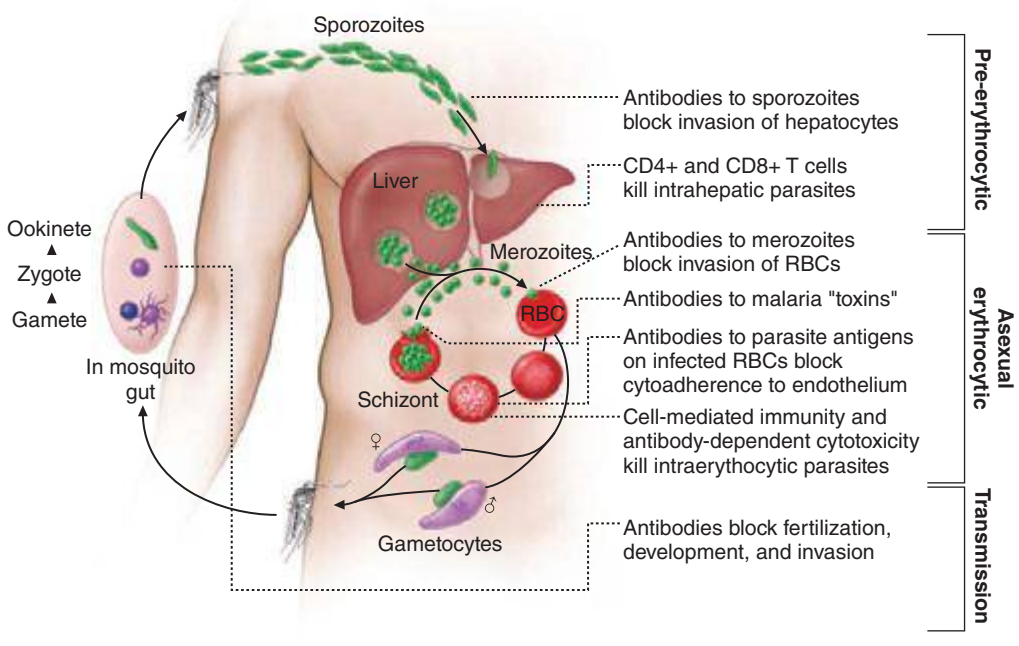

FIGURE 248-1 The malaria transmission cycle from mosquito to human and targets of immunity. RBC, red blood cell.