Malaria

Malaria is a serious, even deadly infection that has left its mark on human history. Today, in many tropical parts of the world, it continues to threaten human health. Worldwide, more than 300 million people a year suffer from malaria. In tropical Africa, more than a million children die each year of the infection.

Symptoms and Course of Infection

Malaria starts with chills and violent trembling and then progresses to high fever and delirium. The person sweats profusely, is completely exhausted, and has a dangerously enlarged spleen. The disease strikes in a relentless cycle, with symptoms returning every 2 to 4 days. The waxing and waning symptoms reflect the parasite's life cycle. The frequent crises cause anemia as the person's red blood cell supplies plummet and strain the liver and spleen, both of which process broken-down red blood cells.

A cycle of malaria begins when an infected female mosquito of any of 60 *Anopheles* species feeds on a human (see fig. 21.13). The insect's saliva contains an anticlotting agent, as well as sporozoites, which are small, haploid cells of *Plasmodium falciparum, P. vivax, P. malariae,* or *P. ovale*. The sporozoites enter the human host's liver cells, where they multiply rapidly, eventually emerging as merozoites. Some merozoites reinfect liver cells, and others infect blood cells. For the next 2 to 3 days, the merozoites enlarge and divide, finally bursting from the red blood cells. The subsequent infection of other red blood cells, and the release of merozoites into the bloodstream 48 to 72 hours later, is often synchronized throughout the victim's body. This causes the recurrent chills and fever of malaria.

Meanwhile, a few *Plasmodium* cells specialize into gametocytes (sexual forms). When mosquitoes ingest the gametocytes from an infected person's blood, the gametocytes unite in the insect's stomach. After several additional steps, sporozoites form. These move to the mosquito's salivary glands, ready to enter a new host when the insect seeks its next blood meal.

Of the *Plasmodium* species that can cause malaria, *P. falciparum* is the most widespread and virulent, and causes most fatal cases. Recovery is more likely when other species cause the disease. *Plasmodium vivax* and *P. ovale*, however, can remain dormant in the liver for months or years. A person infected with these species may feel well for months, then become ill again.

The type of vegetation in an area determines whether the mosquito and its parasite will thrive. Agriculture often creates conditions that encourage malaria by replacing dense forests with damp rice fields, a haven for moisture-loving mosquitoes. One reason that malaria is relatively uncommon in the United States is that in many places warm weather doesn't last long enough for the mosquitoes to survive and perpetuate the infective cycle. The disease was, however, once widespread in the southern U.S.

History

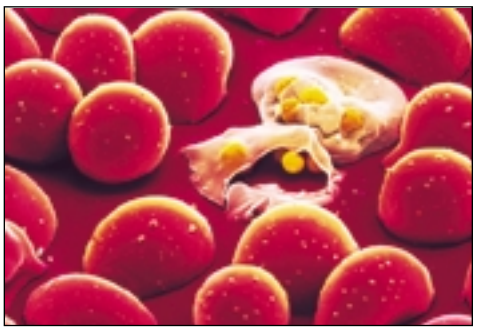
For centuries, people have recognized the link between swamps and recurring malaria. The name of the disease comes from seventeenth-century Italy, where people living near smelly swamps outside of Rome developed mal'aria—"bad air." As long ago as the fourth century B.C., however, Greeks noted that people living near swamps had bouts of fever and enlarged spleens. It took centuries to identify the apicomplexan that causes malaria.

In 1880, French army surgeon Charles Louis Alphonse Laveran saw the parasites in a sick person's blood (fig. 21.C). By the end of the century, researchers had discovered the role the *Anopheles* mosquito plays in transmitting the disease. In 1902, British army surgeon Sir Ronald Ross, using birds as models, deciphered the entire complex cycle of malaria.

Eradication

People were able to treat malaria long before they understood the infective cycle. In the sixteenth century, Peruvian natives gave Jesuit missionaries on their way to Europe their secret malaria remedy—the powdered bark of the cinchona tree. It was not until 1834, though, that French chemist Pierre Joseph Pelletier extracted the active ingredient from

FIGURE 21.C
Emerging Parasites.
Plasmodium cells burst from these red blood cells in a laboratory culture dish.



cinchona bark: quinine, which is still used in some forms, in addition to many other drugs developed to keep pace with *Plasmodium*'s evolving resistance to various drugs. In 1955, the World Health Organization announced an eradication campaign against malaria; by 1976, it admitted failure. Malaria had actually spread through developing nations as people cleared land for farming.

Although we have moderately effective ways to prevent and treat malaria, stemming the illness is very challenging, for biological as well as sociological reasons. Not only does *Plasmodium* continue to develop drug resistance, but nations troubled by poverty and civil unrest struggle to distribute drugs to prevent or treat malaria. Still, certain measures can lower the risk of contracting malaria:

- a drug called mefloquine can prevent malaria when administered weekly for 2 years and can kill parasites within 48 hours;
- bednets soaked in insect repellent keep mosquitoes away;
- screens on windows and doors help keep mosquitoes out;
- wearing long pants and long sleeves, especially during the evening, helps prevent mosquito bites.