Germs, Colonialism, and Darwinian Medicine

• Classification of Human Parasites
• Coevolution of Humans and Their Parasites
• The Mammalian Immune System
• Costly Defenses Against Parasites
• Some Parasites Can Cause Epidemics
• The AIDS Epidemic
• Pathogens May Evolve to Change Their Hosts
• Pathogens in the Colonization of America
• The Problem of Overusing Antibiotics
• Darwinian Medicine
Figure 8.1: The life cycle of *Plasmodium*, the unicellular parasite that is transferred by a mosquito, *Anopheles*, and causes malaria in humans.
The main vector of malaria, *Anopheles gambiae*, seems to have olfactory receptors responding specifically to human odors (Carey et al., 2010).

**Biological significance:** Another example of co-evolution between host and parasite

**Medical significance:** A potential opportunity to develop a non-toxic way to fight malaria
Figure 8.2: Life Cycle of a Blood Fluke (Schistosoma mansoni).

Infected people (about 200 million) suffer anemia, dysentery, and pain.
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Figure 8.3: Antibody-mediated Immunity

After Campbell and Reece (2002)
Overview of the Immune System

From Campbell and Reece (2002)
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**Figure 8.4: Sickle cell anemia** caused by abnormal self-assembly of hemoglobin molecules in humans homozygous for the globin $\beta^S$ allele.

[a] normal red blood cell  
[b] sickled red blood cell  
[c, d] photograph and interpretative diagram of hemoglobin S self-assembled into a rod-shaped complex

*From Kalthoff (2001)*
Figure 8.5: Sickle cell anemia vs. resistance to malaria

Parents:

Gametes:

Children:

 susceptable to malaria
 resistant to malaria
 die from sickle cell anemia

$\beta^A = \text{normal (wild type) globin gene}$

$\beta^S = \text{mutant (6 glu}$ \rightarw{} val) allele$
Figure S8.a: Distribution of *falciparum* malaria and hemoglobin variants

*From Sutton (1988) p. 547*
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A parasite’s basic reproductive rate, $R_0$, is the average number of new infections caused by the first infected individual in a population.

$R_0 > 1 \implies$ Disease becomes epidemic
$R_0 < 1 \implies$ Disease dies out

$R_0$ is not correlated with the mortality rate, i.e., the fraction of infected hosts killed by the parasite.
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Figure 8.6 Prevalence of HIV infection. In 2005, about 40 million people worldwide lived with HIV. Estimated prevalence rates among adults (15-49 years) ranged from < 0.1% in some countries to >30 % in others (2006 UNAIDS Report).
No vacancy. When $CCL3L1$ (red) occupies the CCR5 receptor on CD4 cells, it blocks HIV’s entry.

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When Pizarro captured Atahualpa in 1532, small pox had already decimated the Inca population and had unleashed a civil war.
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Rapid succession of antibiotics needed to treat life-threatening infections with *Staphylococcus aureus*.

Years indicate when *Staphylococcus* strains resistant to each drug were first observed. Resistant strains cause about a million hospital-acquired infections each year in the USA.

*From Science* vol. 293: *p.* 1788
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