

ing environment; this membrane can regulate the passage of molecules in and out of the cell.

Beyond these similarities, living organisms can exhibit a vast array of intracellular (i.e., within-cell) complexity. Fundamentally, all organisms can be classified into two categories: prokaryotes and eukaryotes. **Prokaryotes** are single-celled organisms that are enclosed by a plasma membrane but lack membrane-bound organelles and a **nucleus** (the membrane-bound structure that contains a cell's DNA). Prokaryotic DNA, which typically takes the form of a single loop, clusters in a central region called the **nucleoid**. **Eukaryotes**, on the other hand, can be single celled or multi celled and are typically much more complex than prokaryotes. Unlike prokaryotes, the cells of eukaryotes have a nucleus, as well as membrane-bound organelles and multiple linear strands of DNA. Most living things visible with the naked eye are eukaryotes, whereas prokaryotes are microscopic bacteria or archaea (microscopic organisms that are abundant in extreme habitats and in plankton of the open sea).

Pathogenic Microorganisms

There are four main pathogenic (i.e., infection-causing) microorganisms: 1) parasites, 2) fungi, 3) bacteria, and 4) viruses.

PARASITES

Pathogenic organisms can be independent (i.e., self-reliant for survival) or parasitic, meaning that they depend on another organism to live. **Parasitic organisms**, or parasites, can live within or get their food from another organism, also known as the host organism. Three major types of parasites cause disease in humans: protozoa, helminths, and ectoparasites.

Found within the intestine, blood, or tissue of infected individuals, **protozoa** are **unicellular** (i.e., single-celled) organisms that can reproduce in humans. Without treatment, an infection from a single protozoa can progress into a serious infection.

Helminths, on the other hand, are more complex **multicellular** (i.e., many-celled) organisms that take the form of parasitic worms in their adult stages. Unlike protozoa, fully matured helminths are visible with the naked eye and cannot multiply within humans. There are three main types of hel-



A parasitic worm that has been removed from an intestine.

minths:

1. **Flatworms**, which are relatively simple organisms that lack internal body cavities
2. **Thorny-headed worms**, which are armed with a spikey proboscis, or elongated appendage at their head, that allows them to latch onto the gastrointestinal tracts of their hosts where they reside
3. **Roundworms**, which in their larval (i.e., immature) stage can cause disease by infecting various body tissues. Adult worms also can reside in our gastrointestinal tract, blood, and lymphatic system.

Finally, **ectoparasites** are organisms that inhabit the skin but not the body of the host. Most ectoparasites are invertebrates (i.e., they do not have a spine), and most invertebrate ectoparasites take the form of insects, arachnids, and crustaceans. Common ectoparasites affecting humans include lice, fleas, and some mites. Ectoparasites may cause disease directly, or they can cause disease indirectly by acting as a **vector**, which is an animate agent that carries and transmits an infectious pathogen from a reservoir to a susceptible host.

FUNGI

Fungi are eukaryotic organisms that can be unicellular, taking the form of yeasts or molds, or multicellular, taking the form of more complex organisms such as mushrooms. They are distinguishable from