Vibrations of a longitudinal wave are parallel to the wave motion

You can create another type of wave with a spring. Suppose that one end of the spring is fixed and that the free end is pumped back and forth along the length of the spring, as shown in **Figure 12.** This action produces compressed and stretched regions of the coil that travel along the spring. The displacement of the coils is in the direction of wave motion. In other words, the vibrations are parallel to the motion of the wave.

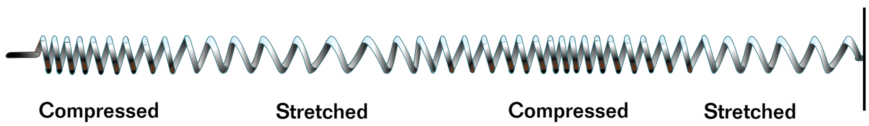

Figure 12
As this wave travels to the right, the coils of the spring are tighter in some regions and looser in others. The displacement of the coils is parallel to the direction of wave motion, so this wave is longitudinal.

When the particles of the medium vibrate parallel to the direction of wave motion, the wave is called a **longitudinal wave.** Sound waves in the air are longitudinal waves because air particles vibrate back and forth in a direction parallel to the direction of wave motion.

longitudinal wave

a wave whose particles vibrate parallel to the direction the wave is traveling

A longitudinal wave can also be described by a sine curve. Consider a longitudinal wave traveling on a spring. **Figure 13(a)** is a snapshot of the longitudinal wave at some instant t, and **Figure 13(b)** shows the sine curve representing the wave. The compressed regions correspond to the crests of the waveform, and the stretched regions correspond to troughs.

The type of wave represented by the curve in **Figure 13(b)** is often called a *density wave* or a *pressure wave.* The crests, where the spring coils are compressed, are regions of high density and pressure (relative to the equilibrium density or pressure of the medium). Conversely, the troughs, where the coils are stretched, are regions of low density and pressure.

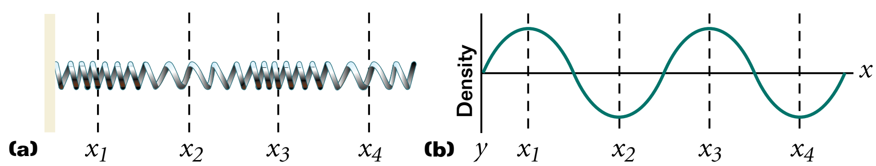

Figure 13
(a) A longitudinal wave at some instant t can also be represented by **(b)** a graph. The crests of this waveform correspond to compressed regions, and the troughs correspond to stretched regions.

PERIOD, FREQUENCY, AND WAVE SPEED

Sound waves may begin with the vibrations of your vocal cords, a guitar string, or a taut drumhead. In each of these cases, the source of wave motion is a vibrating object. The vibrating object that causes a sine wave always has a characteristic frequency. Because this motion is transferred to the particles of the medium, the frequency of vibration of the particles is equal to the frequency of the source. When the vibrating particles of the medium complete one full cycle, one complete wavelength passes any given point. Thus, wave frequency describes the number of waves that pass a given point in a unit of time.