Sound:
Learning Goals for Students and Teachers

Overview of science content storyline: To produce a sound you can hear, an object has to vibrate. All soundmakers vibrate and make the air around them vibrate. These vibrations travel through the air in all directions. When the vibrations reach your ears, they make your eardrums vibrate. Then your eardrums send a message to your brain that the vibrations are sound. If the vibrations are big, the sound is loud, and if they're small, the sound is quiet.

Student and Teacher Learning Goals	Additional Teacher Learning Goals
1. To produce sound, objects must move back and forth quickly (vibrate).	1Ta. Vibrating matter produces sound. Human ears are sensitive to a specific range of vibrations ranging from 20 to 20,000 vibrations per second, or *hertz* (Hz). Humans may not be able to detect sound if objects are vibrating slower than 20 Hz or faster than 20,000 Hz. However, other animals, such as dogs, may be able to detect sounds outside this range. 1Tb. Vibrating objects cause sound waves to move through matter. A sound wave is a pressure wave in which a vibrating object causes the matter around it to vibrate. Pressure waves have areas of high pressure (*compressions*) and areas of low pressure (*rarefactions*) that occur in repeating patterns.
2. Vibrating objects can make other objects vibrate.	2Ta. Sound moves as waves in all directions away from the source. These waves transfer kinetic energy through matter. The matter itself isn't transferred through or by the waves—only energy. This type of wave is called a *longitudinal wave*. It's also referred to as a *compressional* or *pressure wave*. Longitudinal waves have compressions (areas of high pressure/density), rarefactions (areas of low pressure/density), wavelength, amplitude, and frequency. 2Tb. Another type of wave is a *transverse wave*, which has crests, troughs, wavelength, amplitude, and frequency. 2Tc. In longitudinal waves, the motion of matter is *parallel* to the motion of the wave. In transverse waves, the motion of matter is *perpendicular* to the motion of the wave. 2Td. Sound waves carry energy that can cause objects to vibrate and move.
3. When something vibrates, it makes the air	3Ta. Our ears detect compressions and rarefactions

around it vibrate.	in the air produced by vibrations, and the brain interprets this information as sound. 3Tb. Sound can't travel in a vacuum because no matter is present to form compressions and rarefactions. 3Tc. Wave diagrams can be used to model sound or pressure waves.
4. Sound moves in all directions away from the source.	4Ta. Sound travels through matter, and the properties of that matter (temperature and humidity level) determine the speed of the sound. 4Tb. The loudness or softness of a sound relates to the amplitude of the wave. Higher amplitudes (bigger vibrations) produce louder sounds. For example, if you turn up the volume on your television, you aren't just turning up the volume; you're turning up the amplitude, which then produces a louder sound. 4Tc. The pitch (highness or lowness) of a sound relates to the frequency of the sound.
5. Vibrating air (sound) can make other objects vibrate. When vibrating air makes our eardrums vibrate, we hear sound.	
6. **Synthesis of earlier lessons:** Vibrating objects produce sound. Vibrations travel through the air in all directions. Vibrating air can make our eardrums vibrate so we hear sound.	