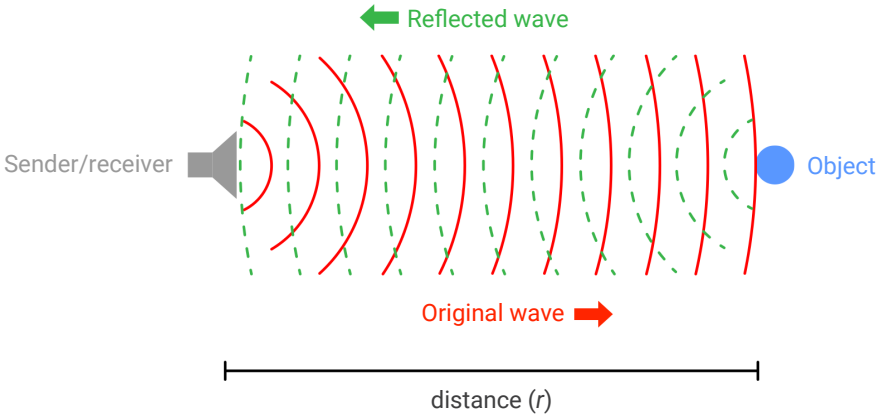
POCUS 101

Understanding the basic physics of ultrasound

How are images created on the screen?

Sound is mechanical energy with frequencies up to 20,000 Hz. Diagnostic ultrasound is pulsed sound waves with frequencies of 2.5–10 MHz.

Like all sound waves, the ultrasound waves travel at a constant velocity through a medium, transferring energy to structures in their path and causing molecules in those structures to vibrate. The reflection of that sound (the echo) from a structure back to the crystals in the transducer is what is seen on the screen. All probes display the returning echoes at a certain frame rate.



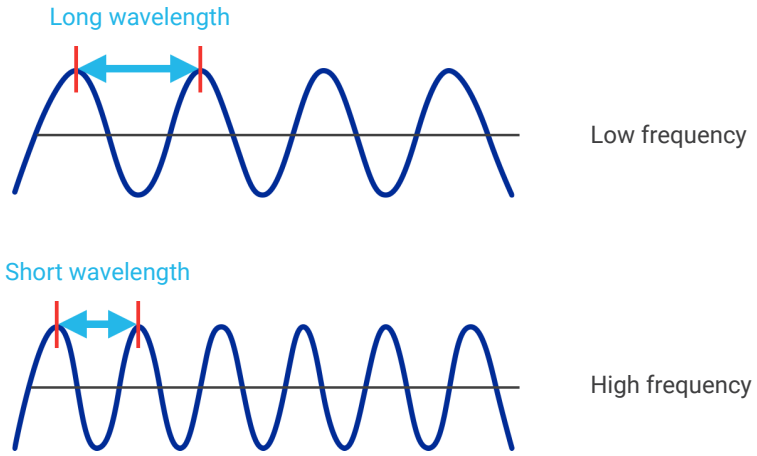
What is density?

Depending on the density of the structure, the echo returned will vary causing it to look different on the screen. If an object reflects all waves back it will be seen as a bright, or hyperechoic, structure (e.g., structures high in calcium, such as bones/stones). If the ultrasound wave travels through the medium it will appear as a black, or anechoic, structure on the screen (e.g., fluid). Structures that allow some ultrasound waves to travel through and some to bounce back appear gray, and are called hypoechoic (e.g., tissue/organs).

Black = fluid (e.g., blood, urine)
Gray = tissue/organ
White = high density tissue/organ (e.g., bone)

What is frequency?

Frequency is the rate at which a wave travels within a material. Different probes use different frequencies to facilitate the imaging of different structures: a low frequency probe uses longer wavelengths to visualize deep structures, and a high frequency probe uses shorter wavelengths to visualize superficial structures.



Low frequency probes 1–5 MHz	**High frequency probes** 10–15 MHz
 Phased-array	 Linear
 Curvilinear	
Visualize deep structures	Visualize superficial structures