

Sound Fundamentals

1



Sound Basics

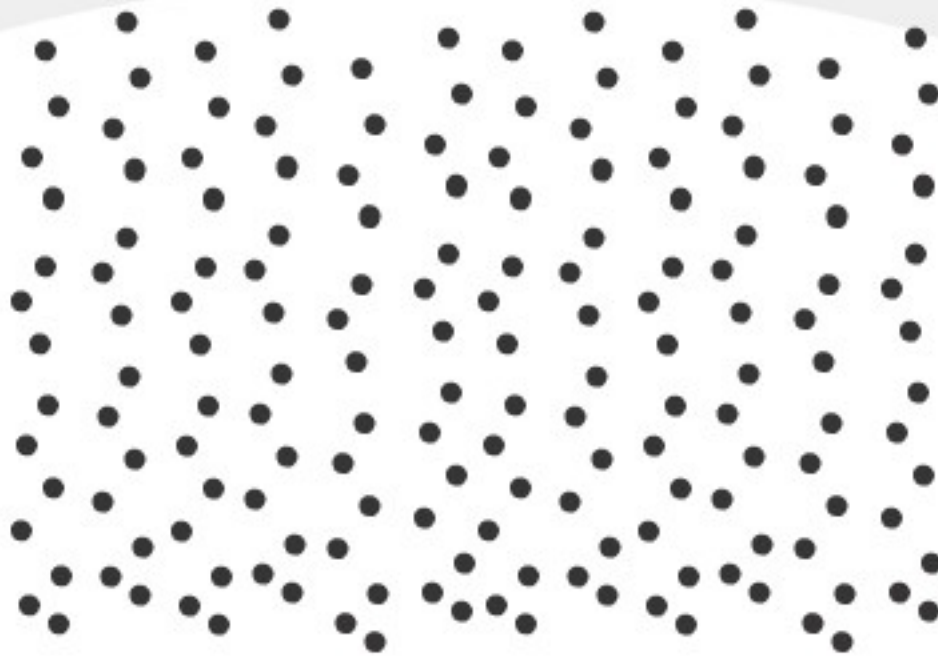
How Sound Works



Sound Source



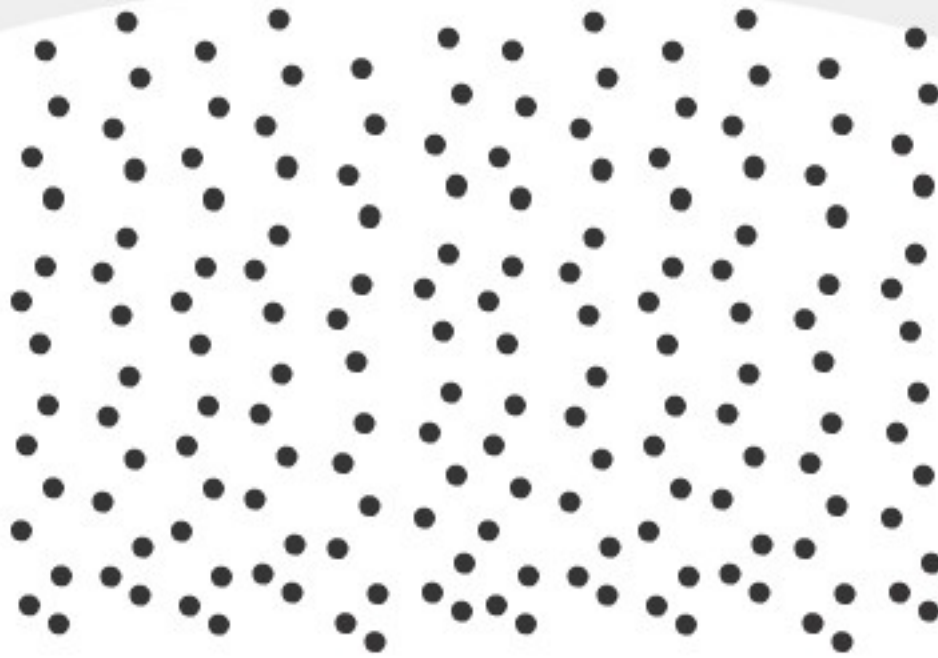
Sound Source



Air Molecules



Sound Source



Air Molecules



Ear



Sound radiates outward from its source . . .

Sound Pressure Waves

A sound source vibrates.

Vibration disturbs air molecules, which move and bump into other air molecules.

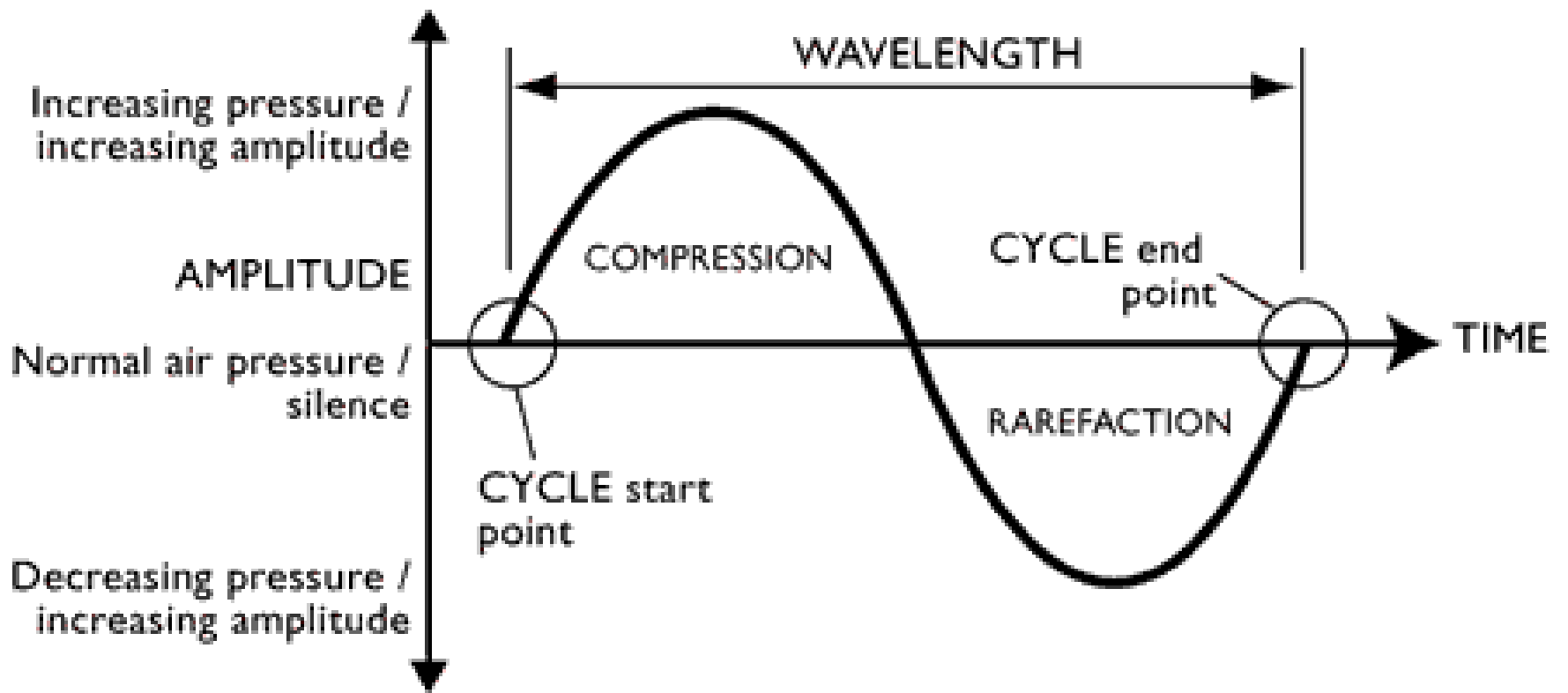
Molecules then pulse in denser and thinner bands of air that radiate away from the source as waves of energy through a medium.

Compression

greater-than-normal atmospheric pressure

lower-than-normal atmospheric pressure

Rarefaction



The medium can be solid, liquid or gas.

Sound travels fastest through solids, then water, then air.

Sound travels slower than light (thus lightning before thunder).

Human Ear

How do we hear?

Outer ear directs the sound waves into the hearing part of the ear.

Inner ear senses the fluctuations in air pressure.

Changes translated into electrical signals understood by the brain.



Pinna

captures/directs sound to ear canal

Eardrum

Pressure moves back and forth

Ossicles

(hammer, anvil, stirrup) amplifies sound before sending to **Cochlea**

Cochlea

transfers energy through tubes with resonant filters sensitive to different frequencies

Organ of Corti

sends raw electrical impulse data to brain

Brain

interprets data according to where hair cells were stimulated

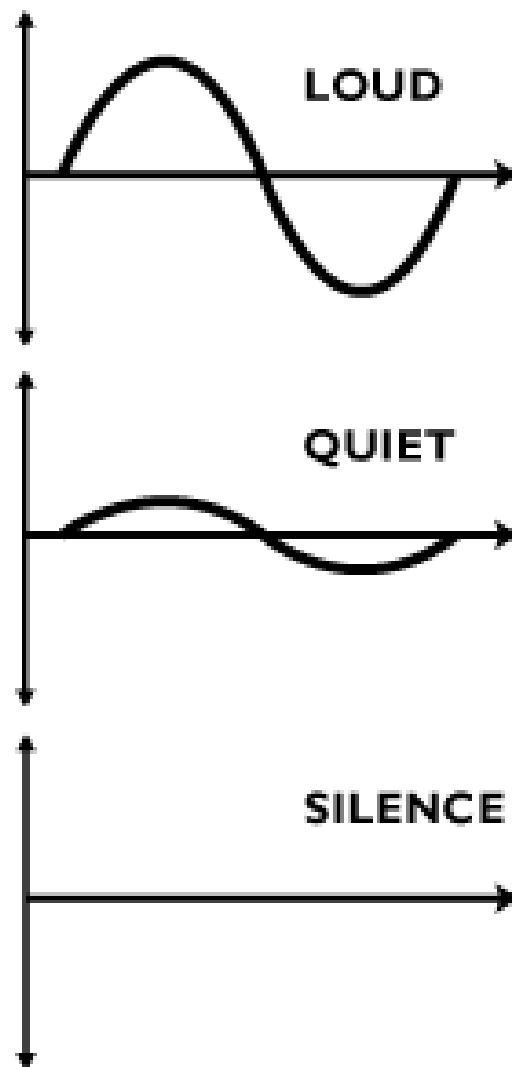
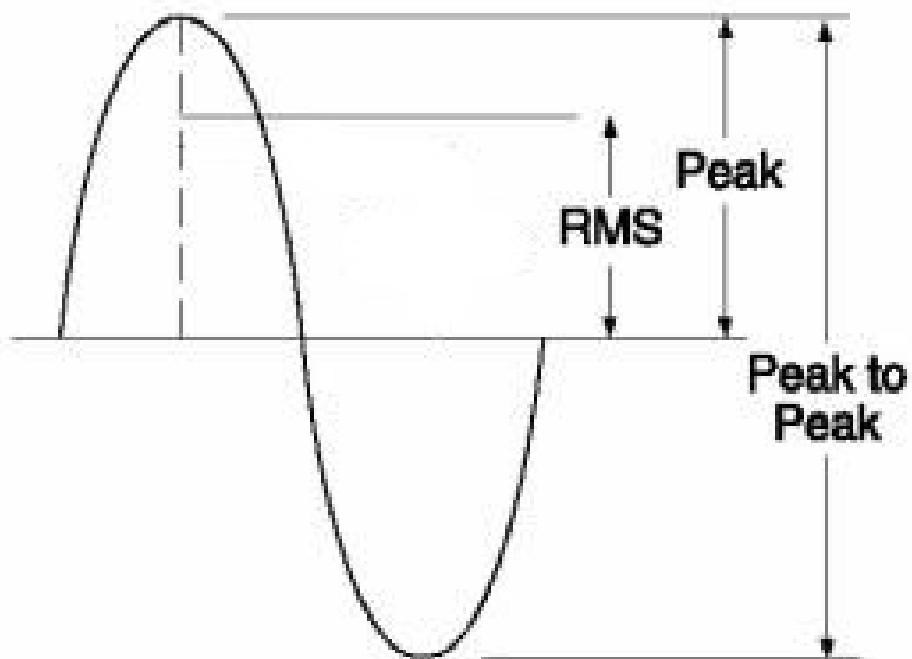
Waveform Characteristics

Amplitude

Distance above or below the centerline of a waveform.

The more intense the sound pressure variation, the louder the sound will appear.

Measured by peak, RMS, or peak to peak.



Peak

maximum positive or negative signal value (centerline to peak)

Peak to Peak

total measurement of positive and negative signal levels (peak to peak)

RMS

Root-Mean-Square = average over time = more closely approximates how we perceive overall loudness

Intensity (or loudness) is a continuum with silence at one extreme and maximum loudness at the other.

Loudness is measured as a COMPARISON:
how much louder is this sound than that one.

We use the term **decibel** to describe these differences in loudness, with each unit of ten representing a tenfold increase in loudness.

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Decibel is named after Alexander Graham Bell, and is abbreviated **dB**.

COMPARISON OF SOUND PRESSURE LEVELS AND LOUDNESS SENSATIONS

Sound Pressure Level (dBA)	Source	Sensation
130	Jet Aircraft at 100' Bass Drum at 3' Auto Horn at 3'	Physical Pain
120		
110	Thunder, Artillery Nearby Riveter	Deafening
100	Elevated Train Discotheque	
90	Loud Street Noise Noisy Factory	Very Loud
80	Truck Unmuffled Police Whistle	
70	Cocktail Party Noisy Office Average Street Noise	Loud
60		
50	Noisy Home Inside General Office	Moderate
40	Conversation Quiet Radio	
30	Quiet Home Private Office	Faint
20	Empty Auditorium Quiet Conversation	
10	Rustle of Leaves Whisper Soundproof Room	Very Faint
0	Threshold of Audibility	

Zero dB, or complete silence, is impossible.

Molecules and atoms make sound, as do the inner mechanisms of our own ears.

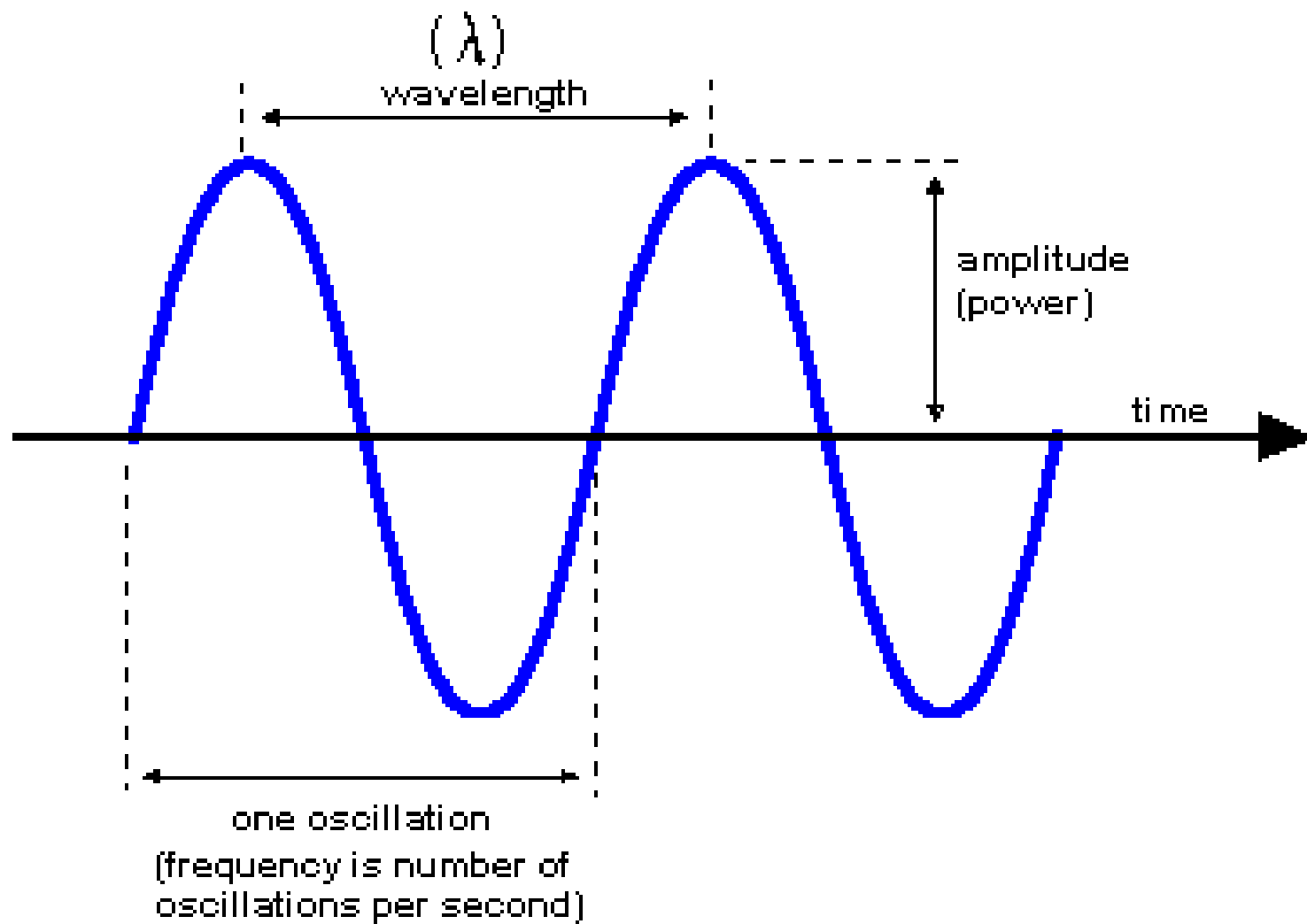
Our bloodstream and nervous system are always “on.”

Frequency

The rate at which a signal repeats a cycle.

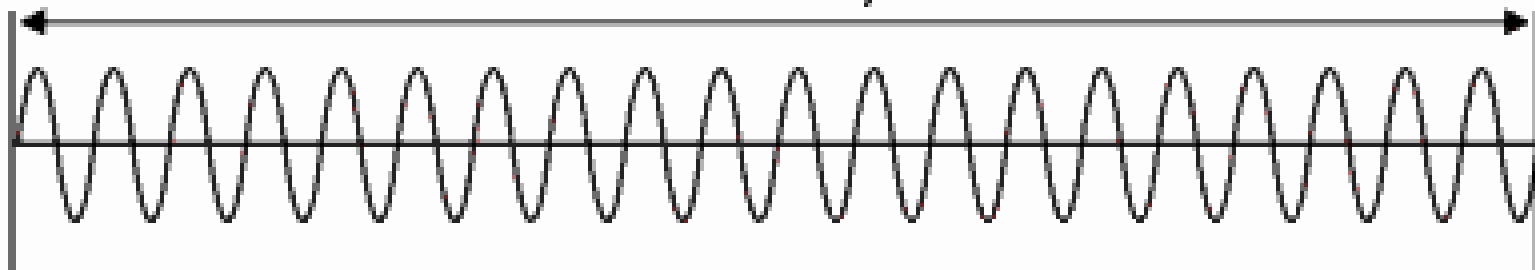
Frequency also known as **pitch**.

Measured in **Hertz** (Hz), cycles per second.



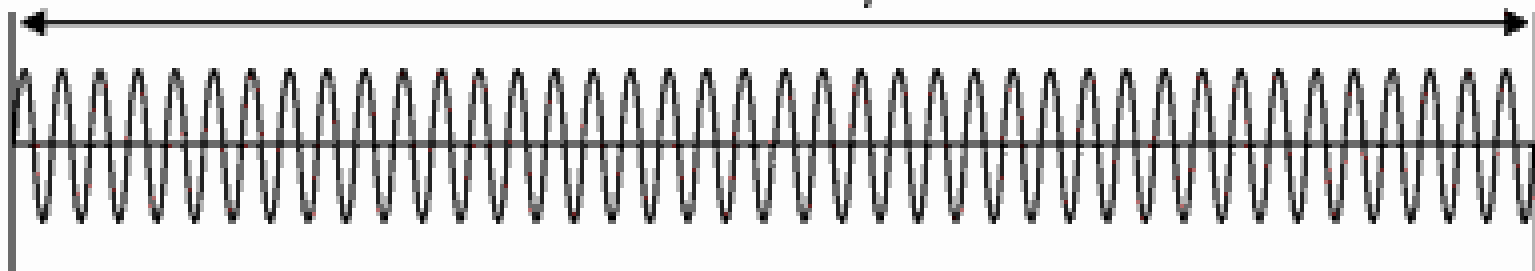
1 second / 20 cycles

20Hz
(20 cps)



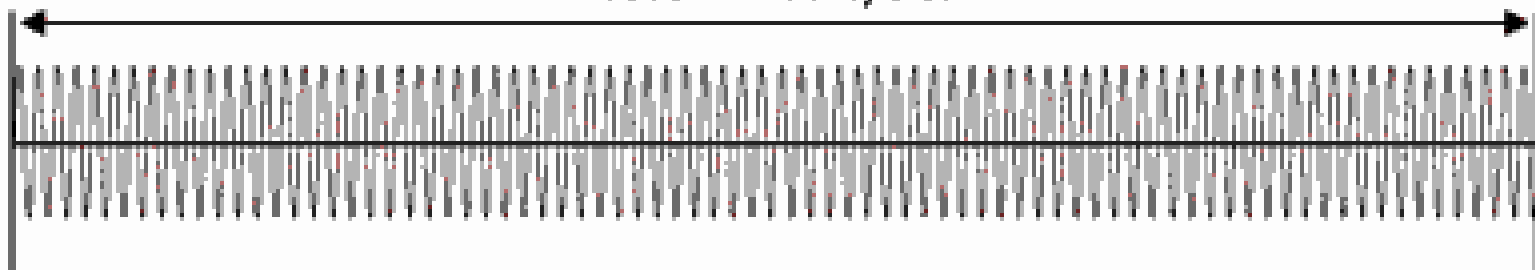
1 second / 40 cycles

40Hz
(20 cps)



1 second / 80 cycles

80Hz
(20 cps)



In a gradient from low to high, normal human hearing ranges between **20-20,000 Hz**.

We start to lose the high end as we age (as early as our twenties).

We favor **250-5,000 Hz** sounds as the most sensitive.

QUIZ #2

1. TRUE or FALSE: normal human hearing ranges between **20-20,000 Hz**.

2.

_____ = greater-than-normal atmospheric pressure.

_____ = lower-than-normal atmospheric pressure.

a. **Rarefaction**

b. **Compression**

