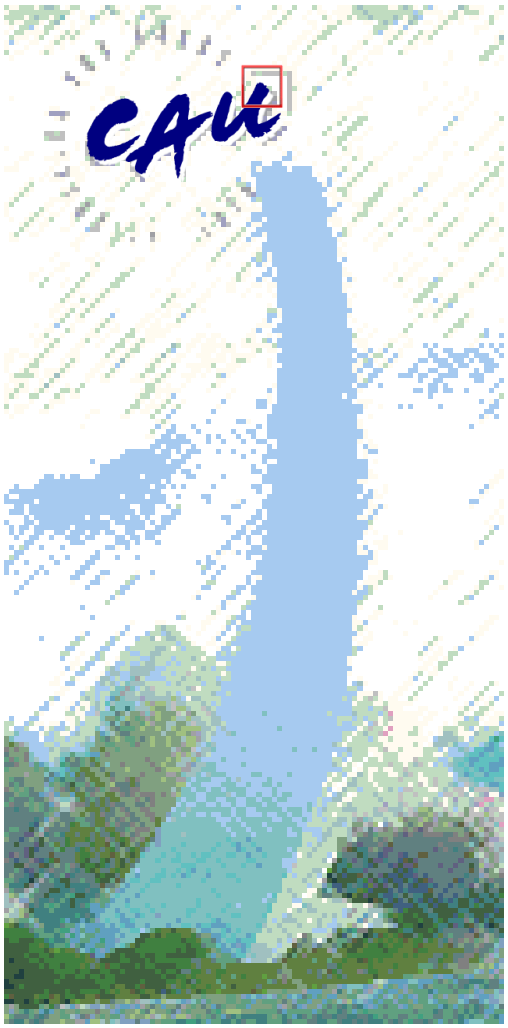


휴먼인터페이스 미디어
Human Interface Media

강의 2
소리와 청각

2020년 가을

소리 – Sound

- 소리는 무엇인가?

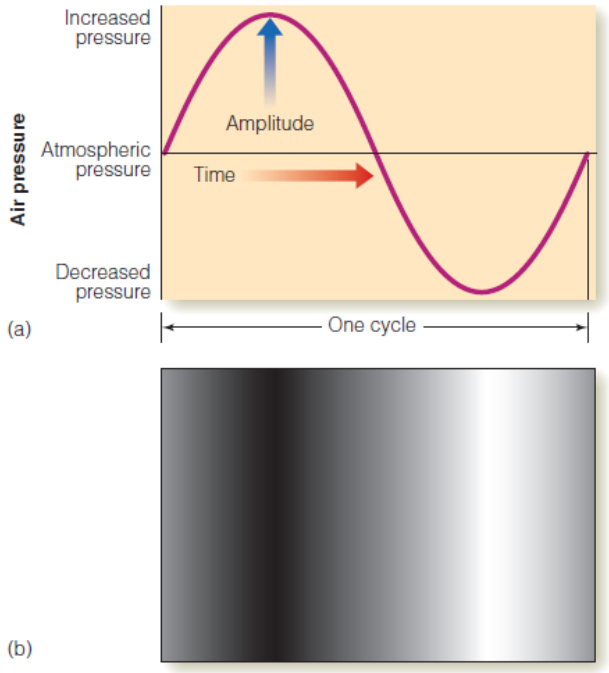
- 숲에서 나무가 쓰러졌는데, 아무도 들은 사람이 없다면, 그 숲에서는 소리가 있었을까?

  – 물리적 정의 (Physical definition)

  – 지각적 정의 (Perceptual definition) :

물리적 소리

- 소리는 공기나 물 같은 매질의 압력 변화를 통해 전달되는 종파이다.
- 단일음:



진폭: Amplitude

Difference in pressure between the high and low peaks of the sound wave energy

주파수: Frequency

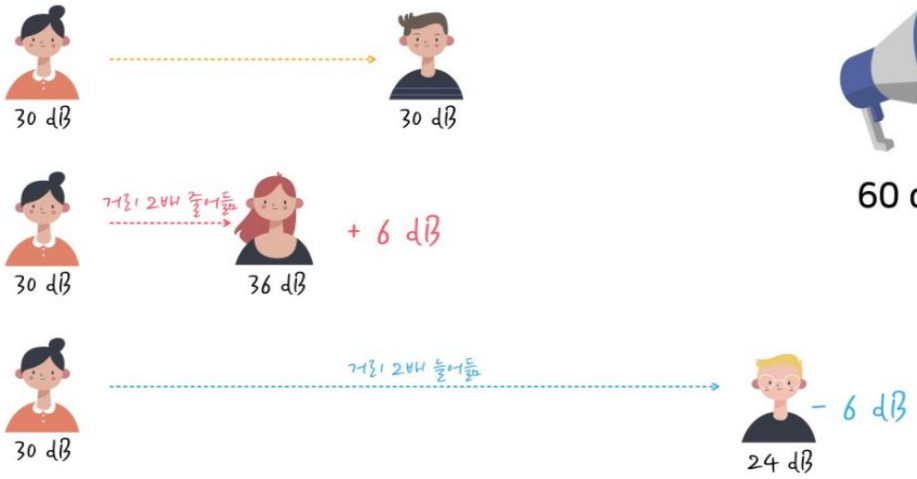
the number of cycles per second (Hz)
the change in pressure repeats

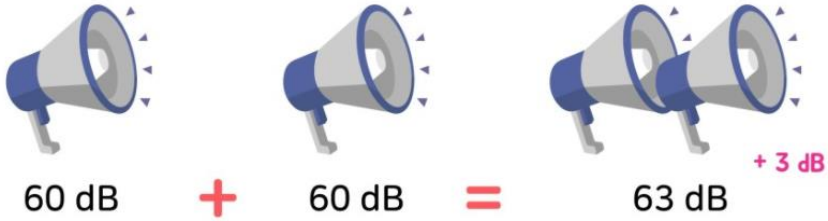
소리 단위

- dB HL – Hearing Level
- dB IL – Intensity Level
- dB SPL – Sound Pressure Level

TABLE 11.1 Relative Amplitudes and Decibels for Environmental Sounds

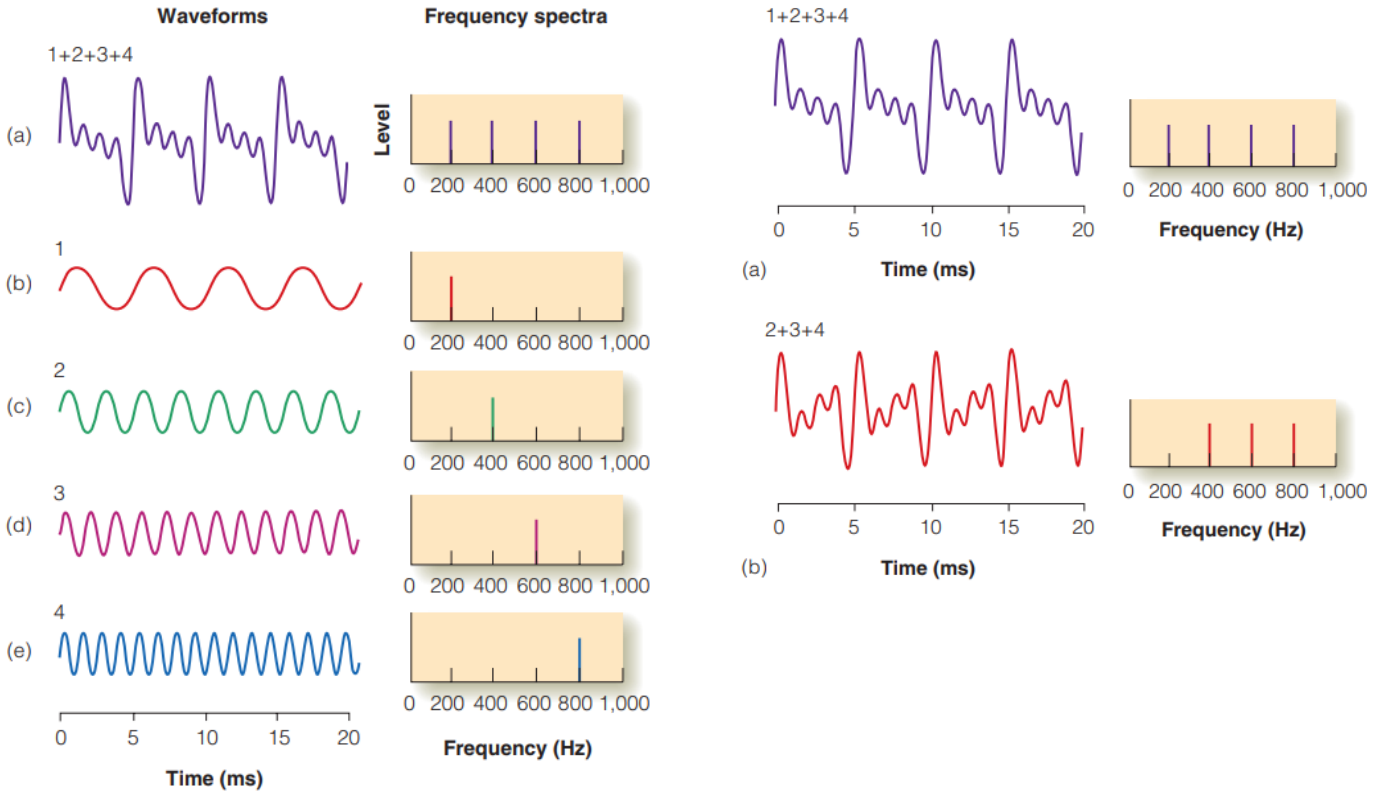
SOUND	RELATIVE AMPLITUDE	DECIBELS (DB)
Barely audible (threshold)	1	0
Leaves rustling	10	20
Quiet residential community	100	40
Average speaking voice	1,000	60
Express subway train	100,000	100
Propeller plane at takeoff	1,000,000	120
Jet engine at takeoff (pain threshold)	10,000,000	140





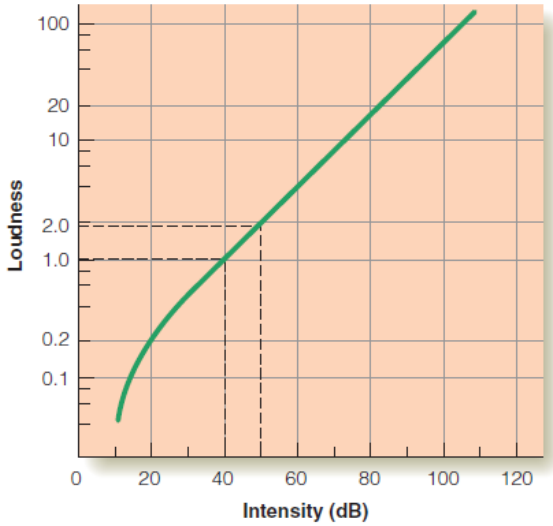
복합음 – Complex Tone

- 두가지 이상의 서로 다른 주파수를 가지는 음이 합쳐진 것



소리의 지각

- Factors:

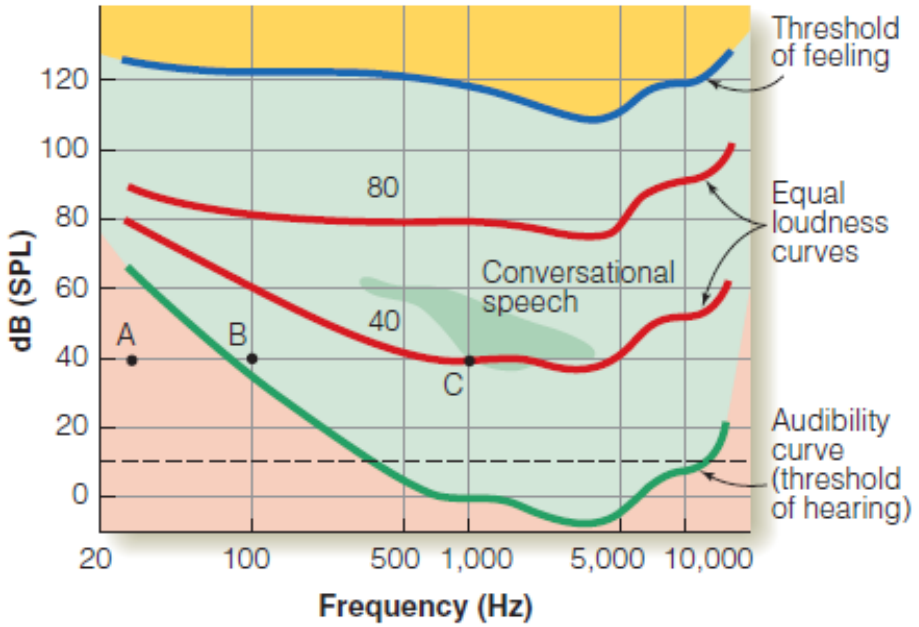


- Loudness

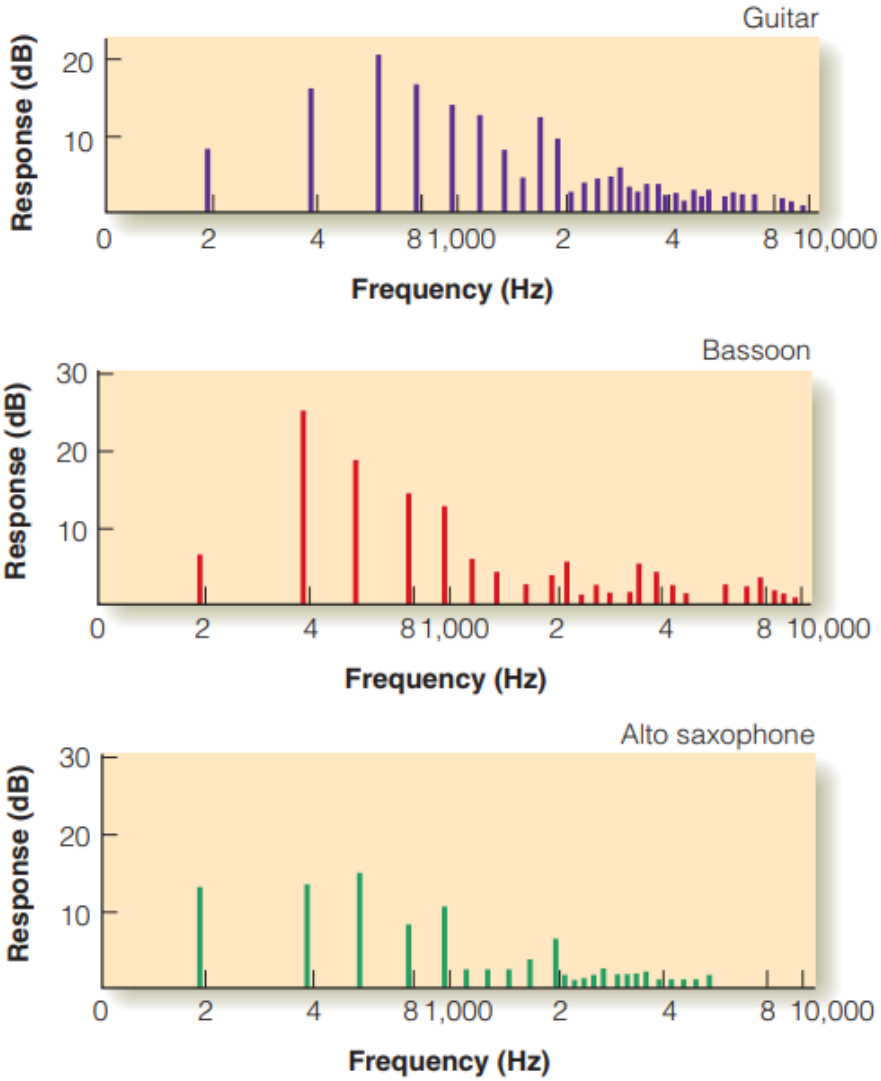
- Pitch
  - the perceptual quality we describe as "high" or "low"

가청 대역

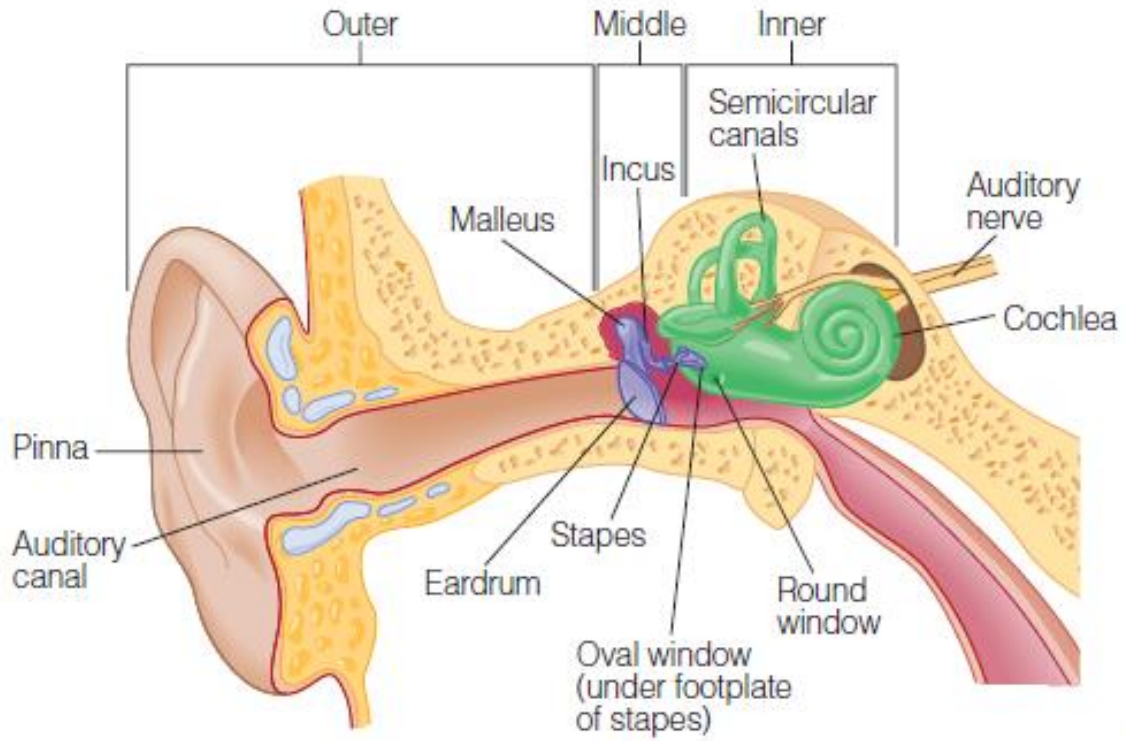
- Range of hearing
  - Two bounds:
  - Frequency range:
  - Loudness Response Range

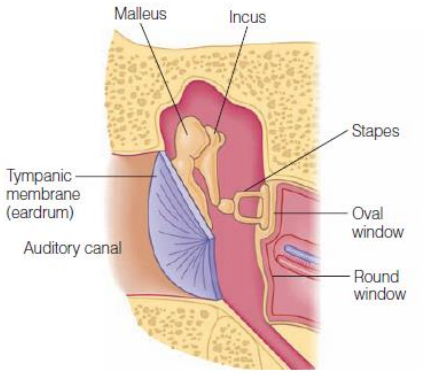


음색 - Timbre

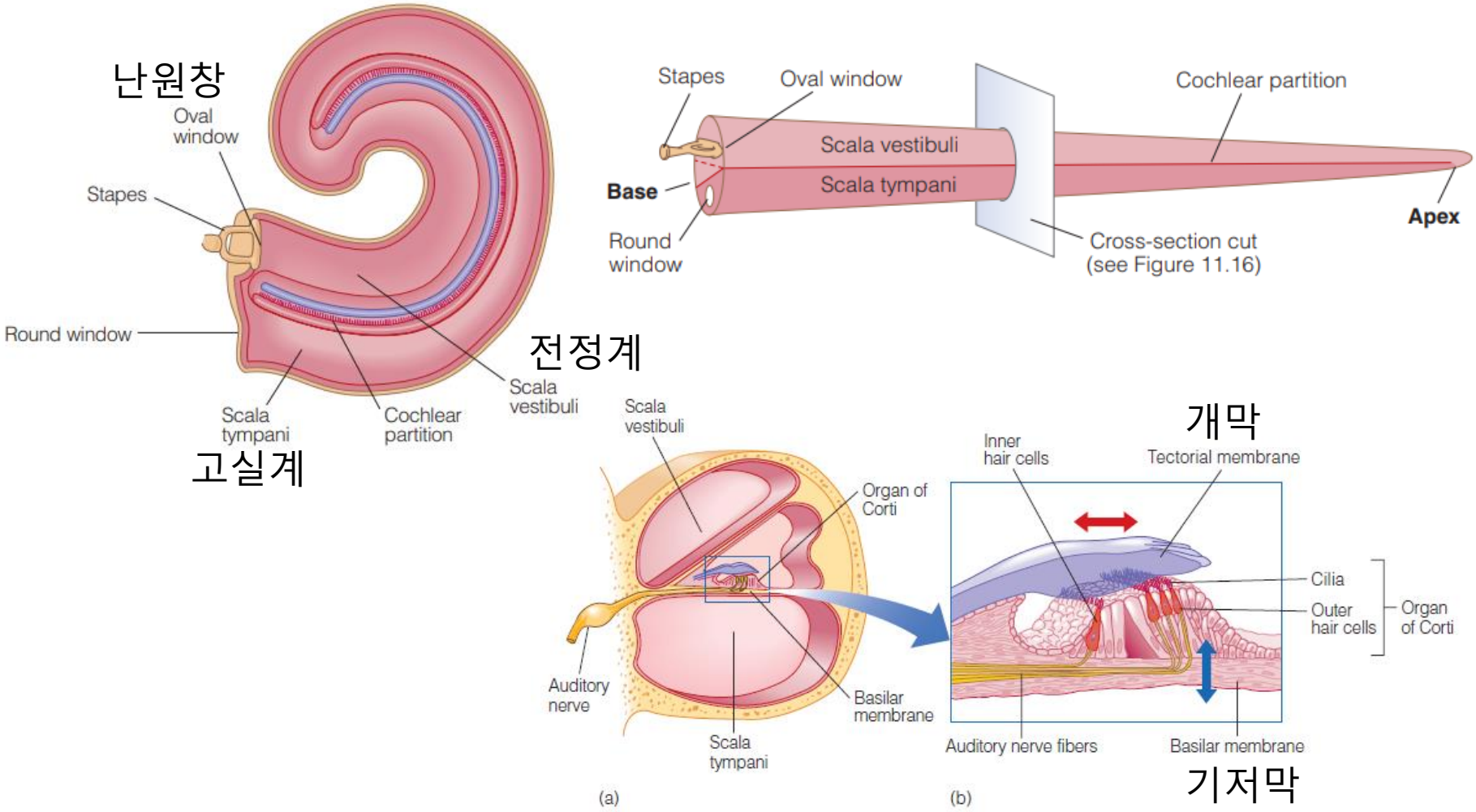

Guitar
Response (dB)
20
10
0
2
4
8
1,000
2
4
8
10,000
Frequency (Hz)
Bassoon
Response (dB)
30
20
10
0
2
4
8
1,000
2
4
8
10,000
Frequency (Hz)
Alto saxophone
Response (dB)
30
20
10
0
2
4
8
1,000
2
4
8
10,000
Frequency (Hz)

귀 - Ear


Outer
Middle
Inner
Semicircular canals
Incus
Malleus
Auditory nerve
Cochlea
Pinna
Auditory canal
Stapes
Eardrum
Round window
Oval window (under footplate of stapes)

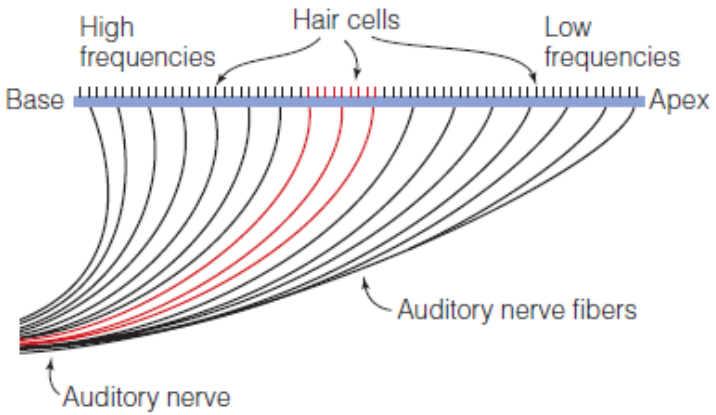

Malleus
Incus
Stapes
Tympanic membrane (eardrum)
Oval window
Auditory canal
Round window

달팽이관 - Cochlea

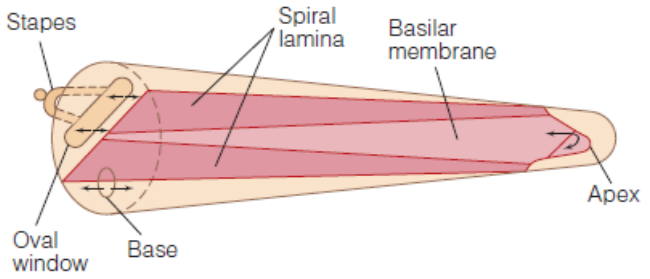


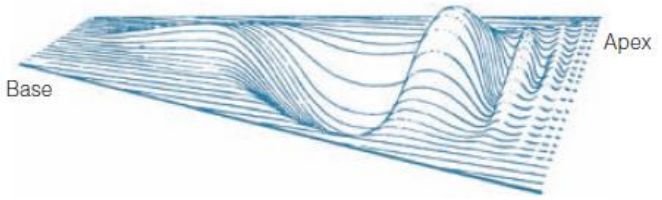
Bekesy's Place Theory of Hearing

- Place theory of hearing

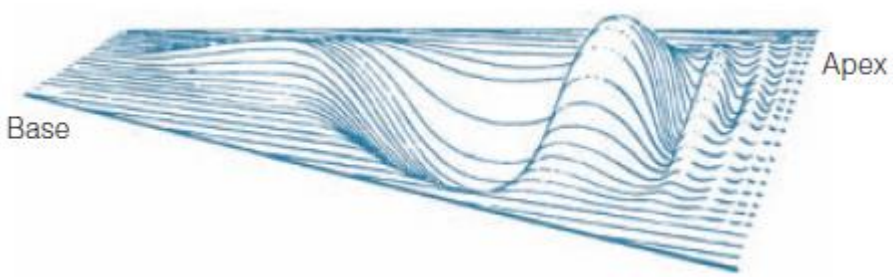


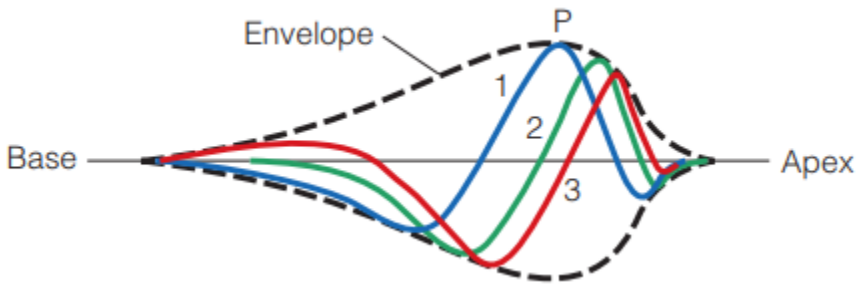
- Cochlea

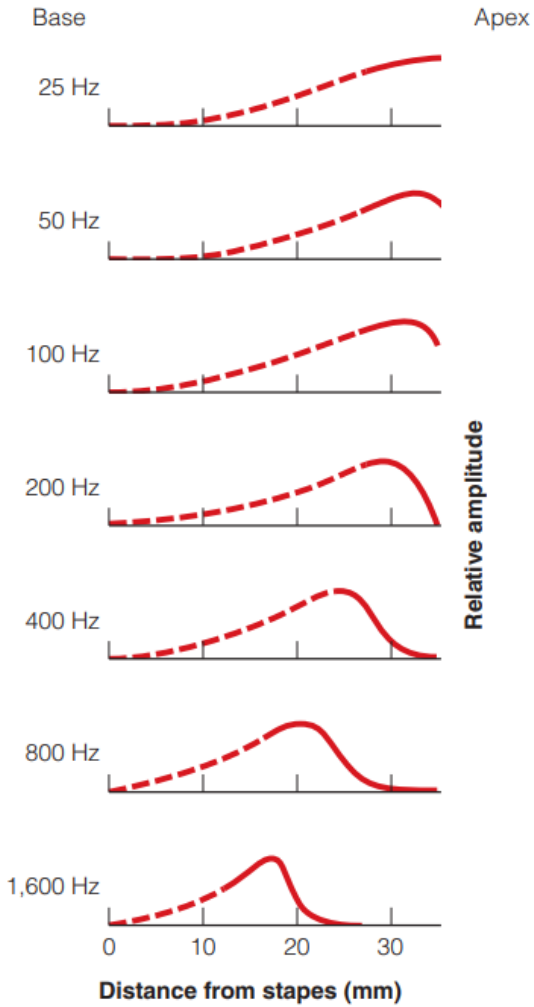




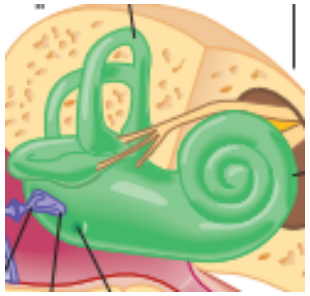
달팽이관의 주파수 반응

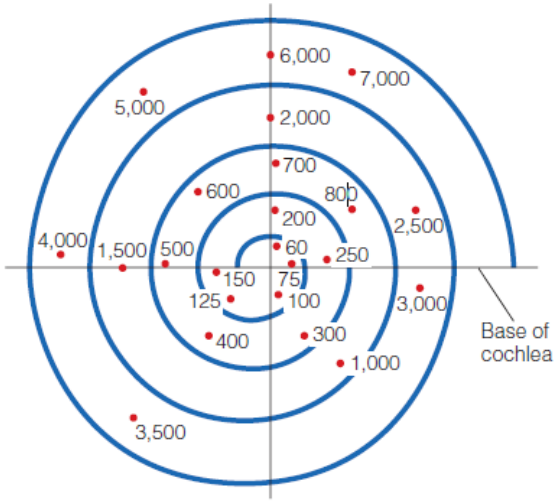

Base
Apex

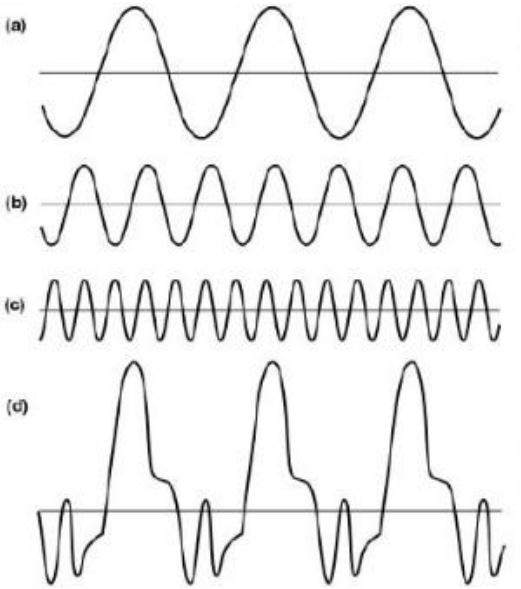

Envelope
P
1
2
3
Base
Apex

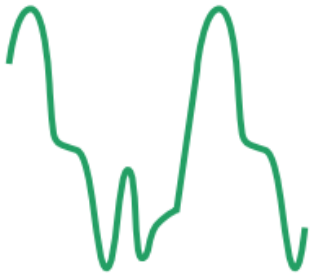

Base
Apex
25 Hz
50 Hz
100 Hz
200 Hz
400 Hz
800 Hz
1,600 Hz
0
10
20
30
Distance from stapes (mm)
Relative amplitude

복합음에 대한 반응

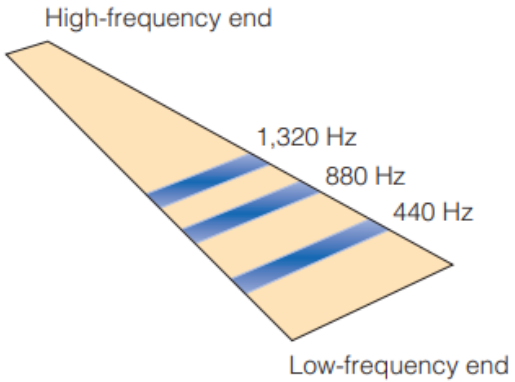








(a) Complex tone
(440, 880,1,320 Hz harmonics)



(b) Basilar membrane

Summary

- Sound, Scale, Tone & Noise
- Anatomy of human ear
- Human Sound perception