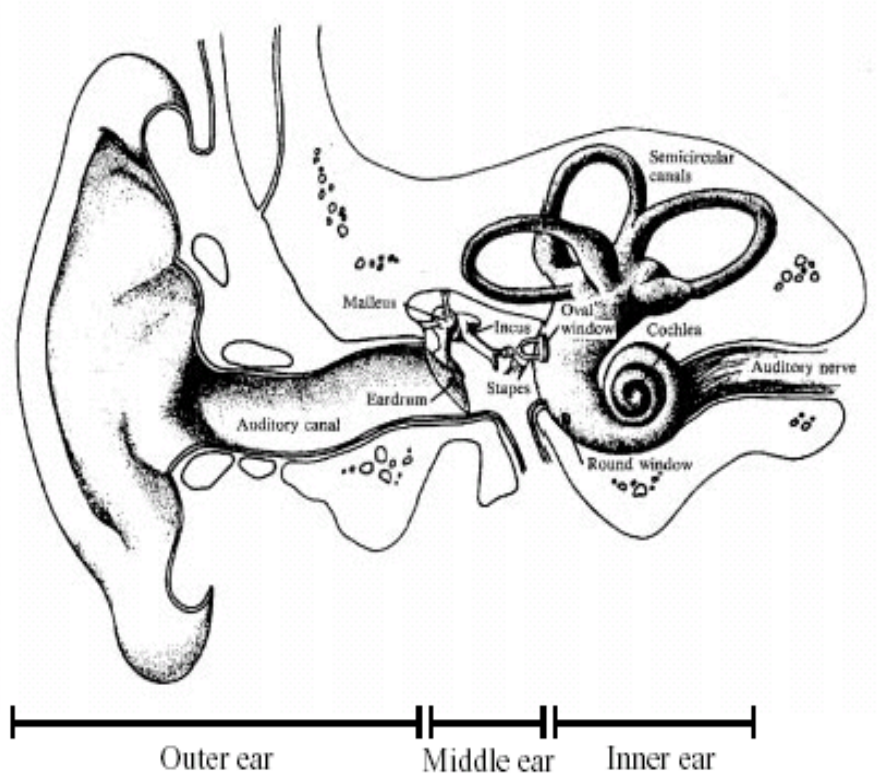
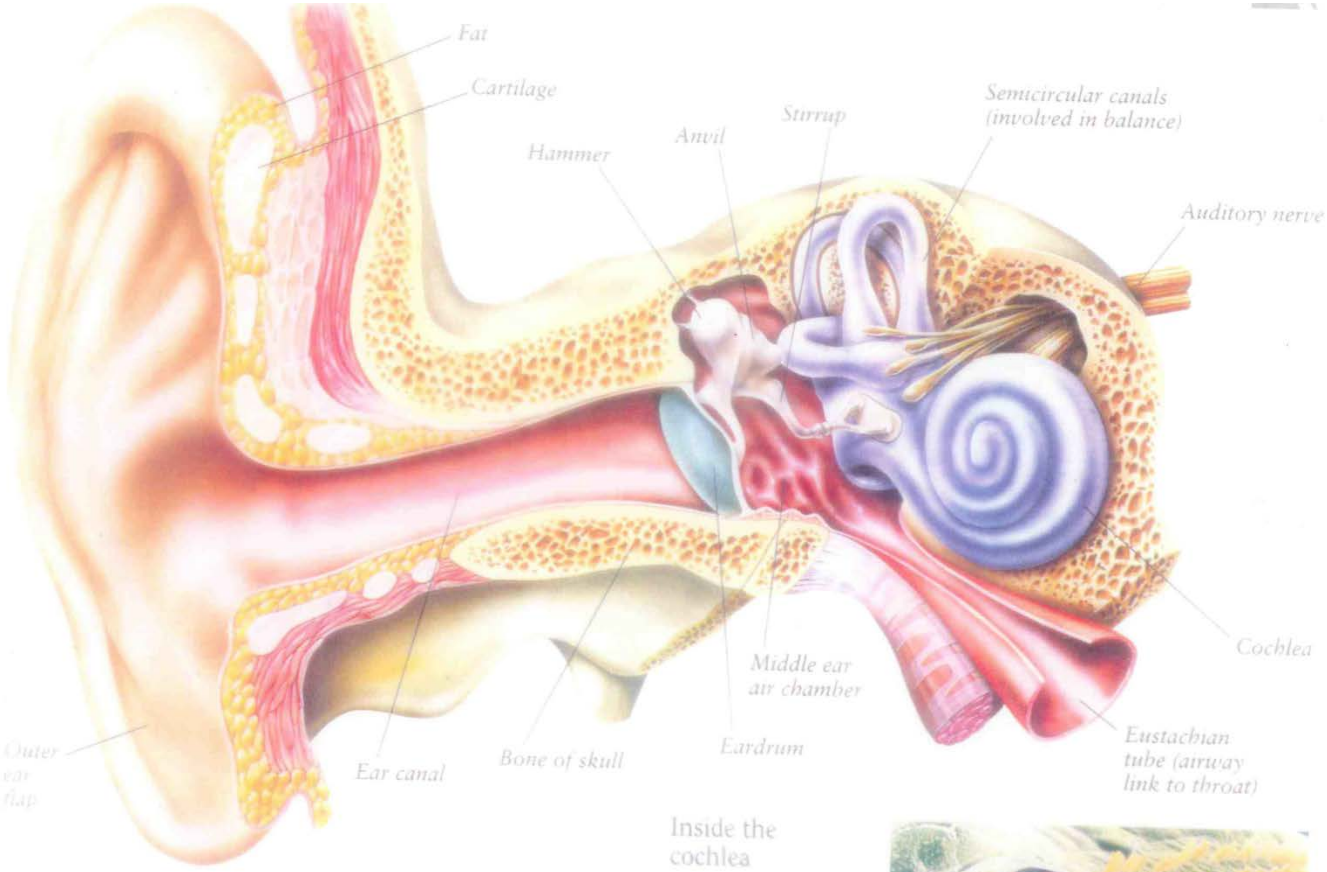
Physiological basis of audition

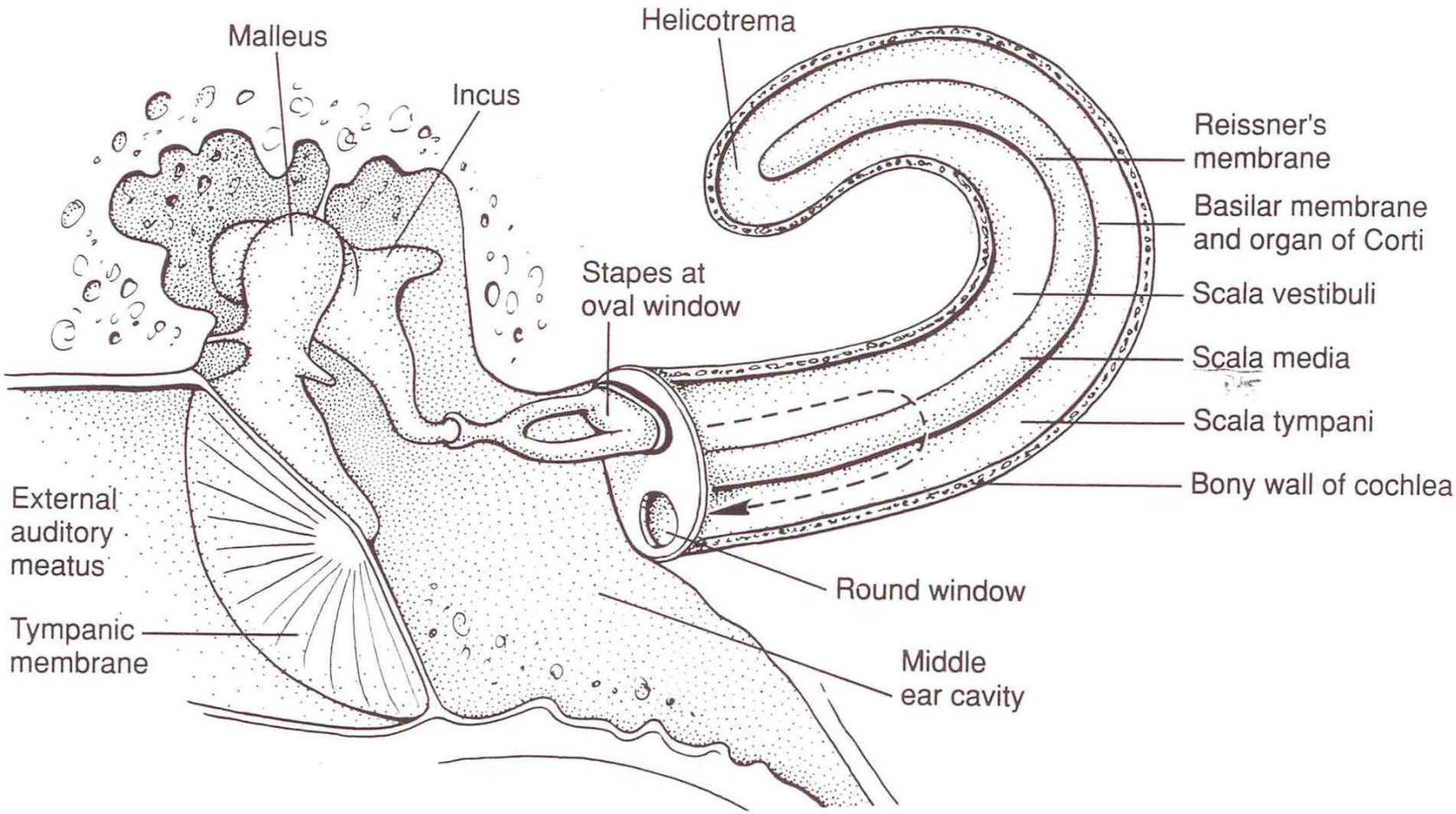
- **Human ear:** A complex mechanism for transducing pressure variations in the air to neural impulses in auditory nerve fibers



Human ear: another view

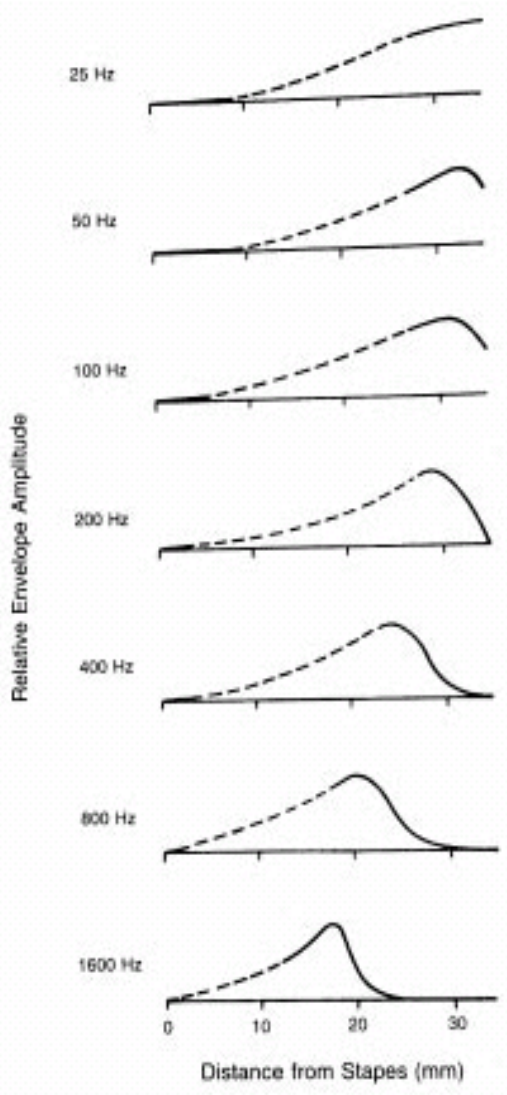


Cochlea


Malleus
Incus
Helicotrema
Reissner's membrane
Basilar membrane and organ of Corti
Stapes at oval window
Scala vestibuli
Scala media
Scala tympani
Bony wall of cochlea
External auditory meatus
Round window
Tympanic membrane
Middle ear cavity

Traveling wave

- **Different frequencies of sound give rise to maximum vibrations at different places along the basilar membrane**
- **The frequency of vibration at a given place is equal to that of the nearest stimulus component (resonance)**
- **Hence, the cochlea performs a frequency analysis**



Auditory nerve response

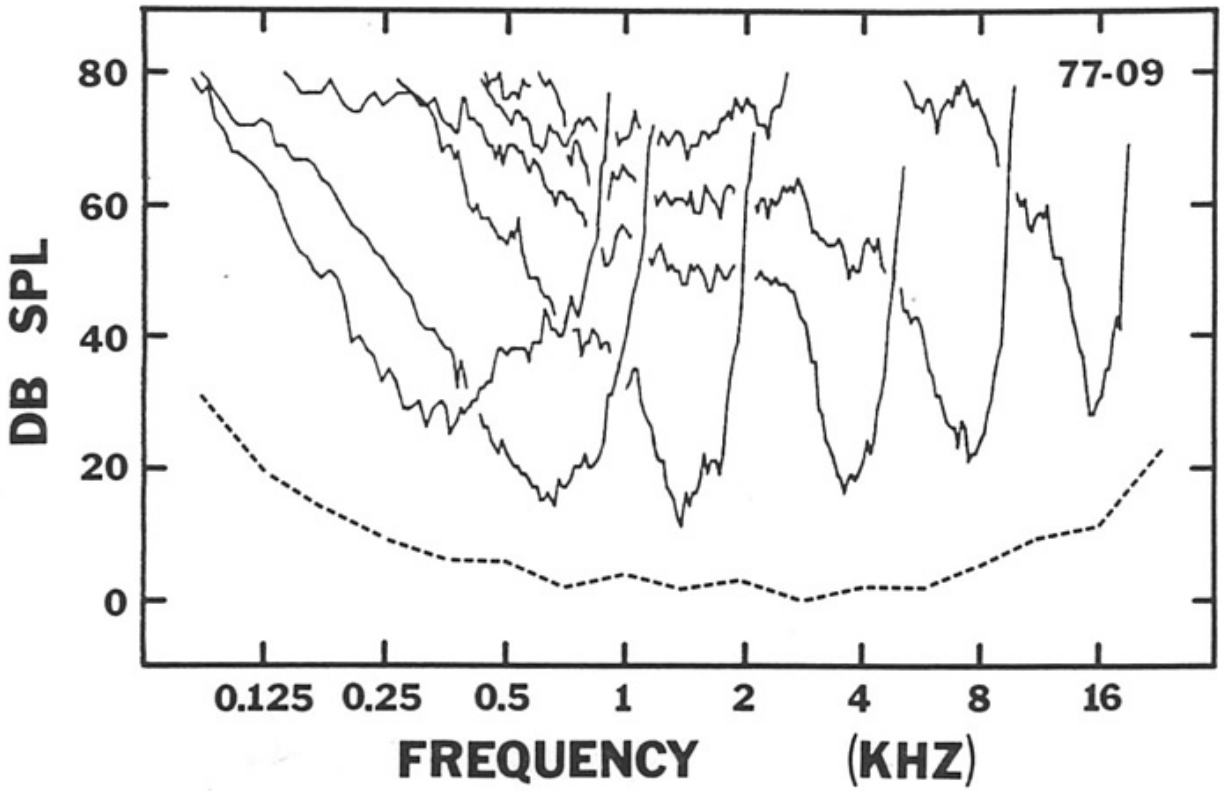
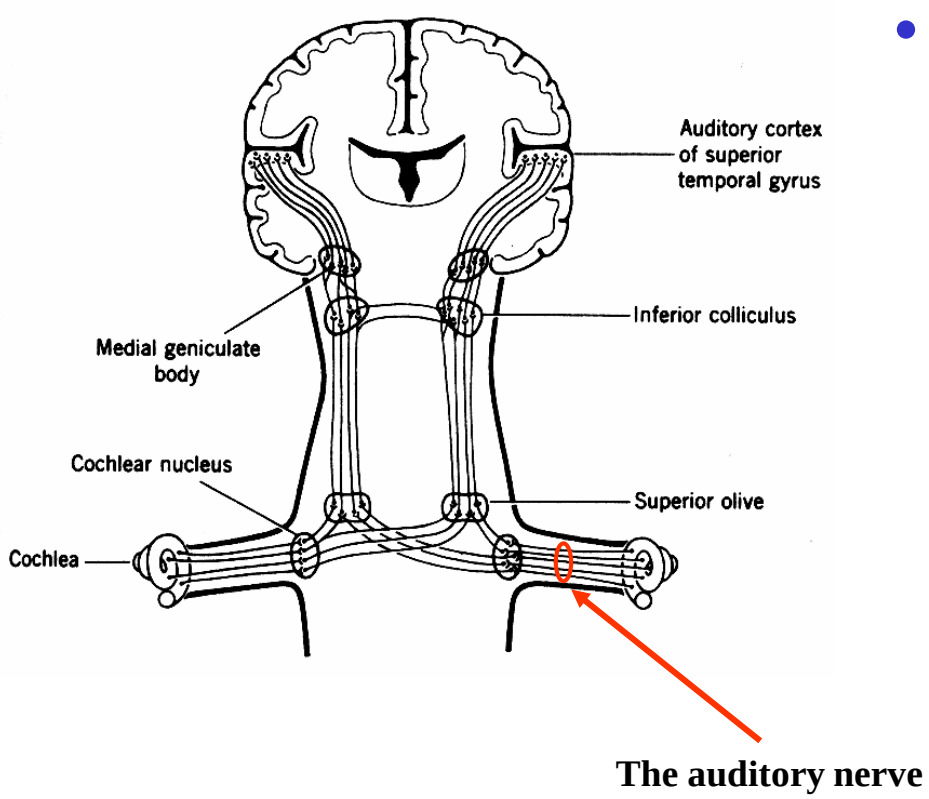


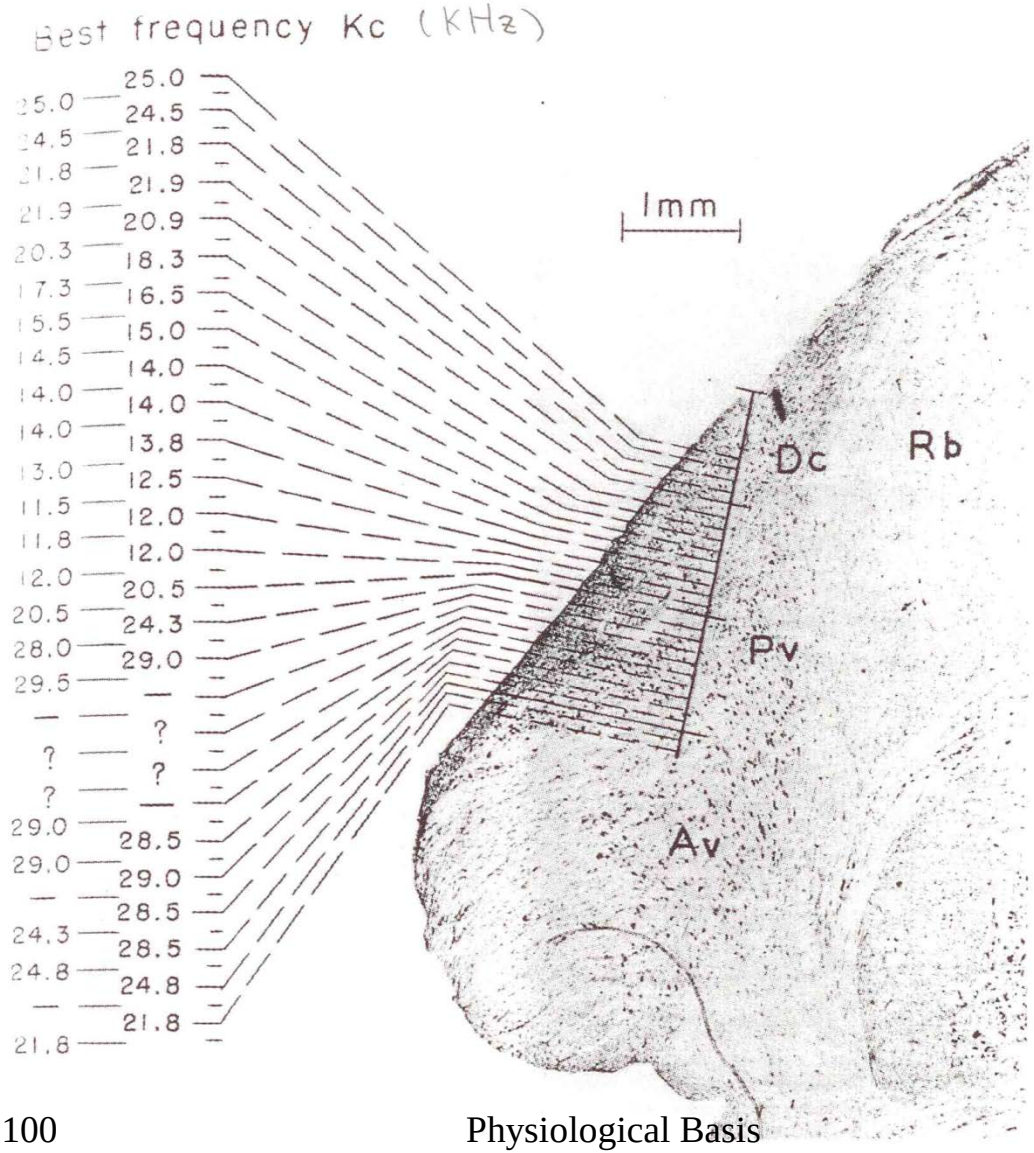
FIGURE 2.2. Representative frequency-threshold tuning curves for cochlear afferents recorded from one chinchilla auditory nerve.

Beyond the periphery



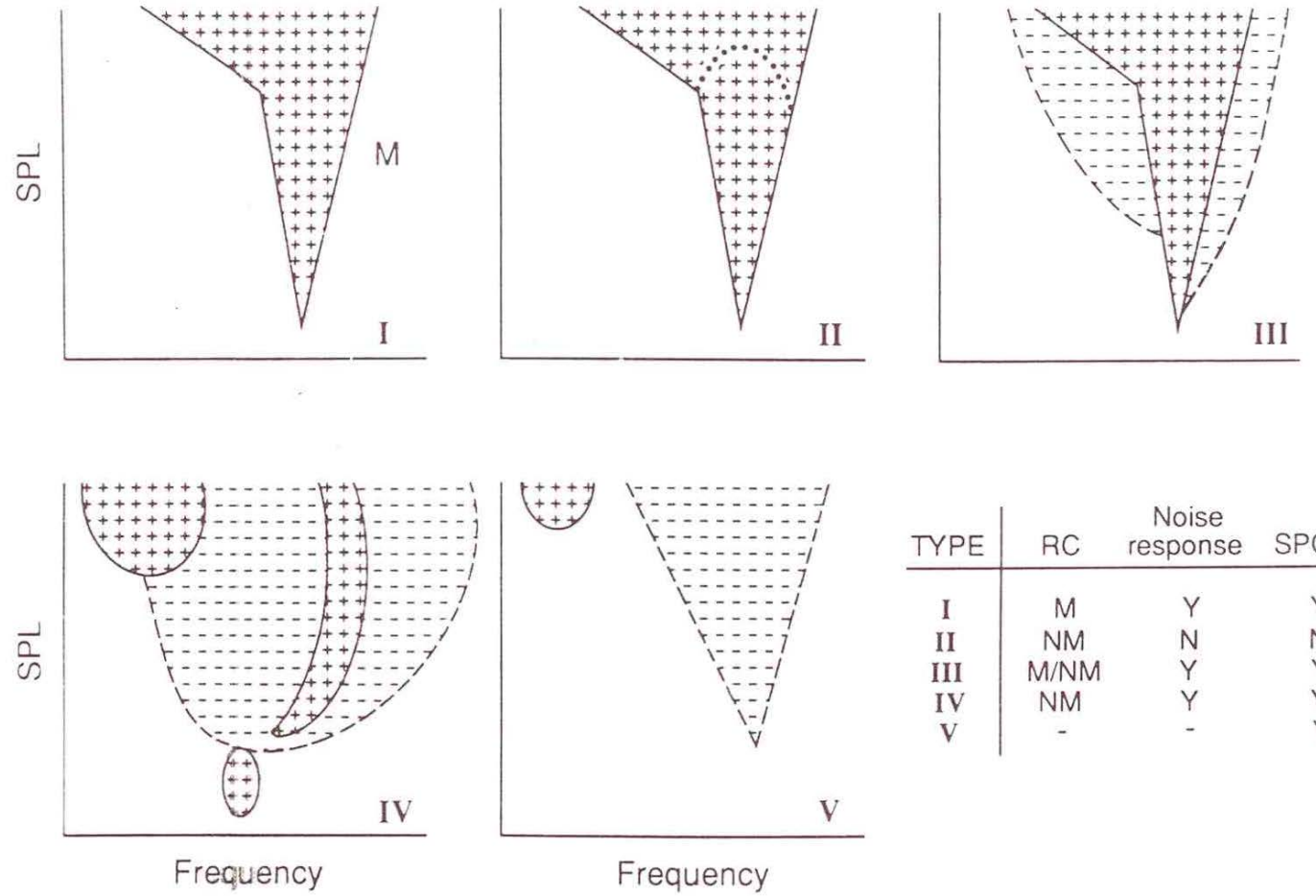
- **The auditory system is complex with four relay stations between periphery and cortex rather than one in the visual system**
  - In comparison to the auditory periphery, central parts of the auditory system are less understood
  - Number of neurons in the primary auditory cortex is comparable to that in the primary visual cortex despite the fact that the number of fibers in the auditory nerve is far fewer than that of the optic nerve (thousands vs. millions)

Cochlear nucleus



A section lying between the transverse and horizontal planes, with the dorsal aspect at the top

Receptive fields of cochlear nucleus units



TYPE	RC	Noise response	SPON	Principal location
I	M	Y	Y	VCN
II	NM	N	N	DCN
III	M/NM	Y	Y	VCN/DCN
IV	NM	Y	Y	DCN (VCN)
V	-	-	Y	DCN

Frequency locking

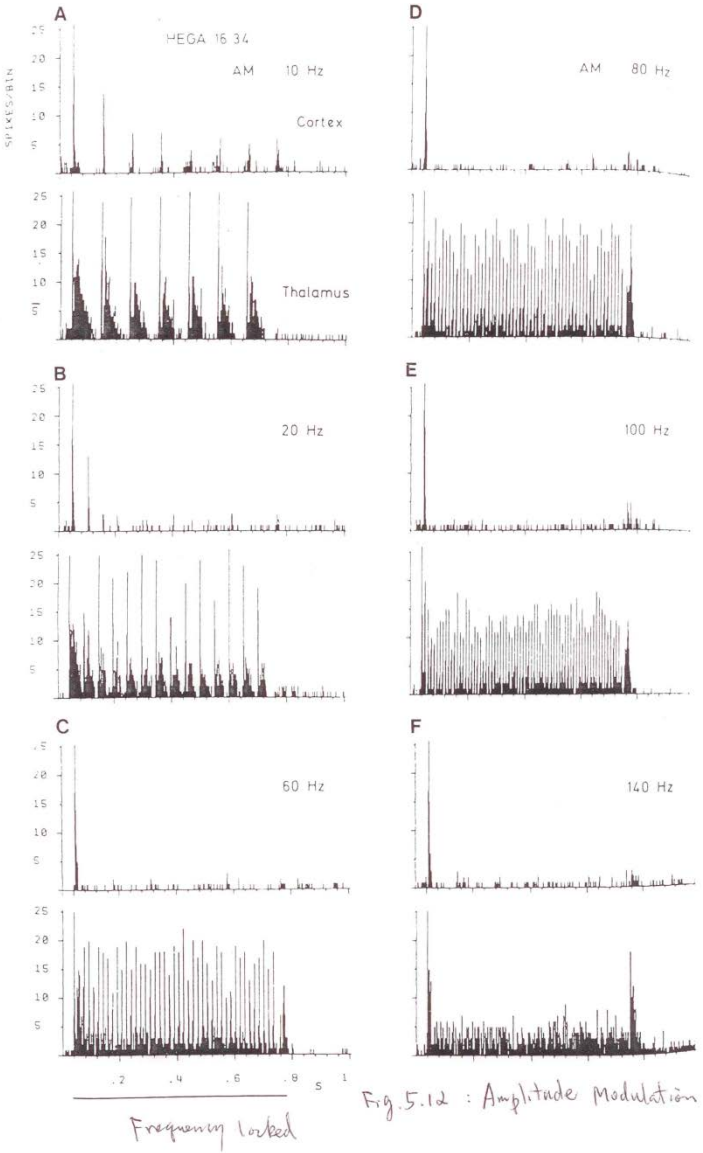
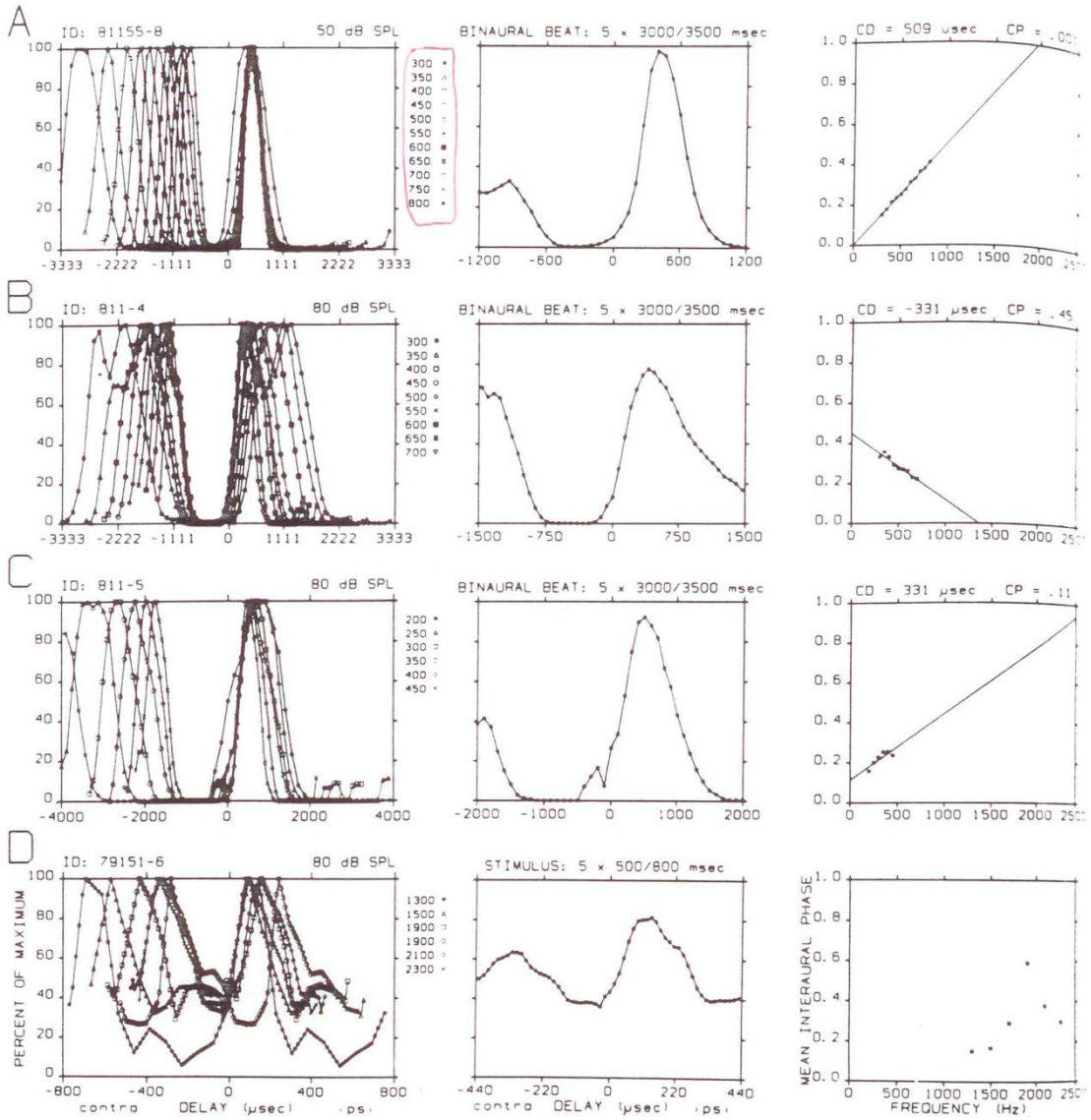


Fig. 5.12 : Amplitude Modulation

Interaural delay sensitivity for 4 ICC neurons



ICC: Central nucleus of the inferior colliculus

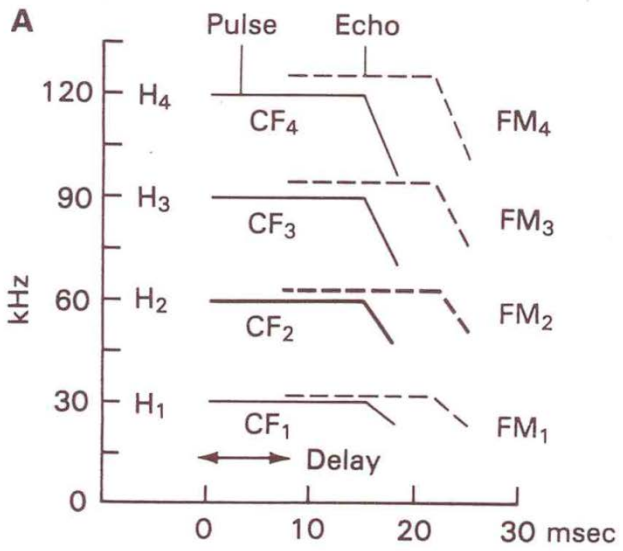
Characteristic delay:

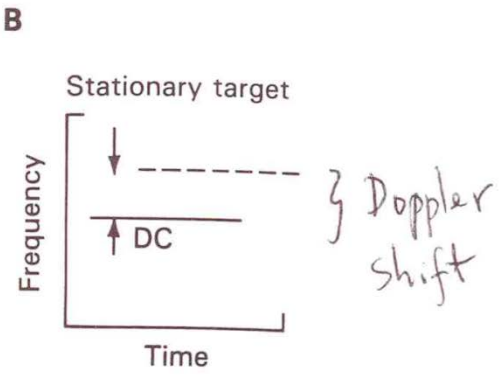
A: 509 µs

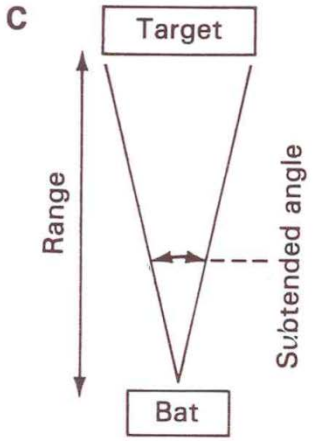
B: -331 µs

C: 333 µs (80% of peak)

Echolocating bat







D

Echo	Target
Doppler shift	Velocity
Amplitude	Subtended angle
Delay	Range
Amplitude + delay	Size
Amplitude spectrum	Fine characteristics
Binaural cues	Azimuth
"Pinna–tragus" cue	Elevation

CF: constant freq.

Auditory system of the bat

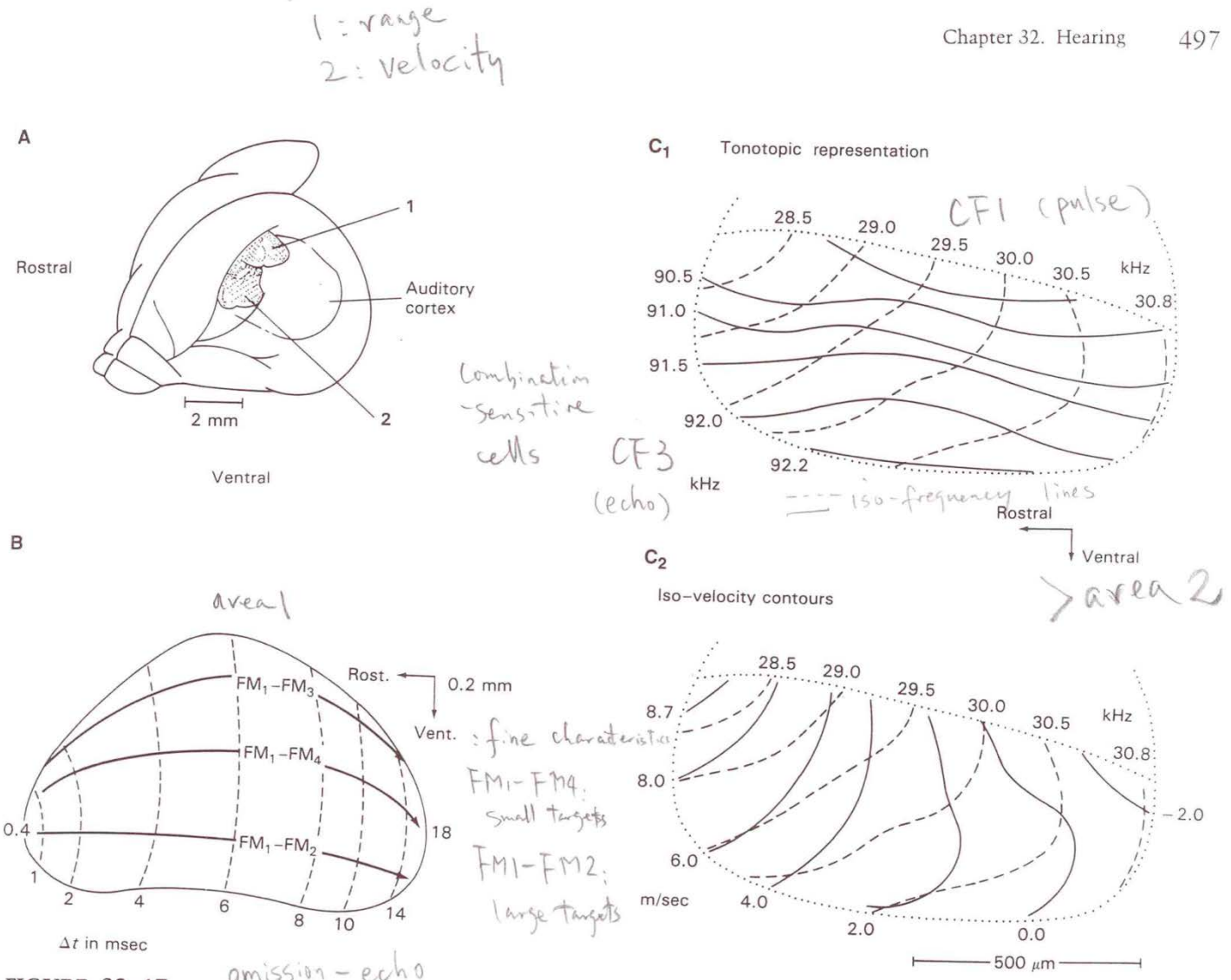


FIGURE 32–17