



VIETNAM NATIONAL UNIVERSITY – HO CHI MINH CITY  
**UNIVERSITY OF INFORMATION TECHNOLOGY**

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## **Chapter 2**

# **AUDITORY MECHANISM**

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# Auditory Transduction

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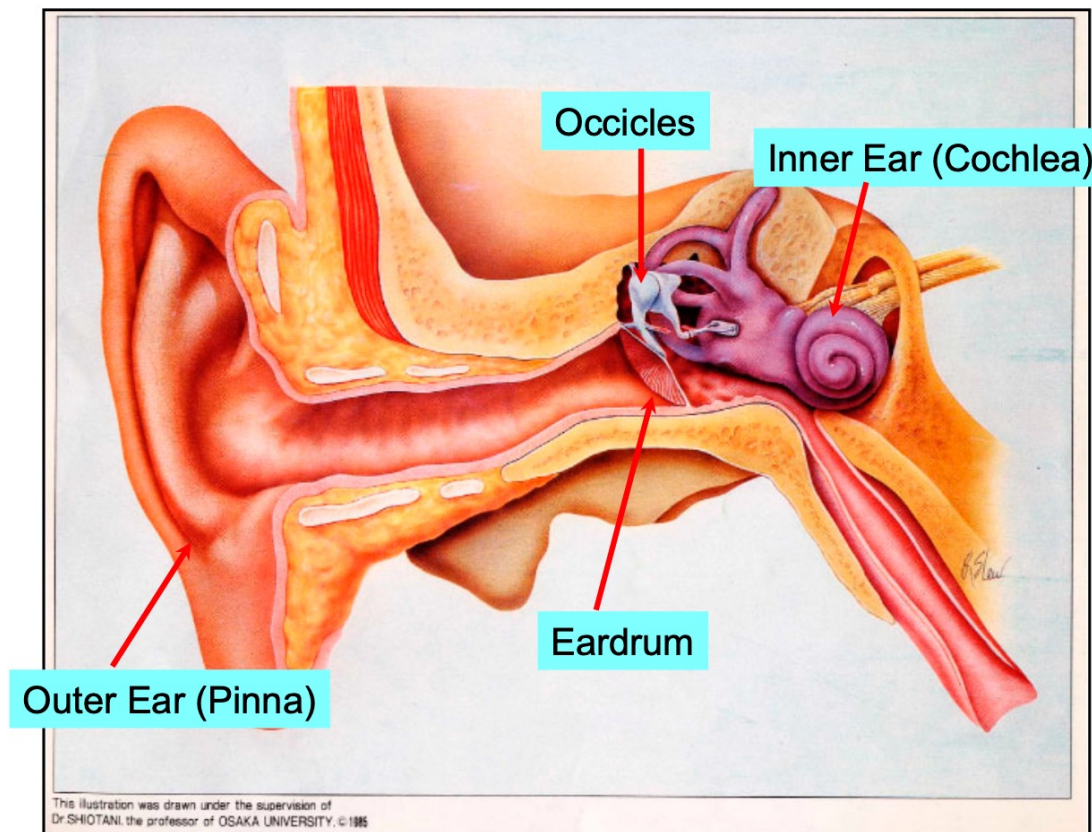
# Origin of Auditory Mechanism

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- ❖ Receptor to sense water flow
- ❖ Receptor to sense balance
- ❖ Ears:
  - ❑ Balance & Hearing
- ❖ Phylogeny:
  - ❑ Fish → Reptiles → Birds → Mammals
  - ❑ Part of the sacculus lengthens → Basilar Membrane lengthens  
→ Audio frequency widens

# Ear

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# Physiology of Auditory Periphery

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- ❖ Outer Ear (Sound Collection)
- ❖ Middle Ear (Impedance Matching)
- ❖ Inner Ear (Vibration/Neural Signal Conversion)
- ❖ Auditory Nerve (Neural Pulse Transmission)

# Outer Ear

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## ❖ Acoustics (Diffraction)

- ❑ Head Related Transfer Function (HRTF) is changed due to influence on head and pinna, when source direction changes.

## ❖ Sound Pressure

- ❑ 10dB up at the entrance of auditory canal (at about 3 kHz)
- ❑ 10dB up by auditory canal resonance (at about 3 kHz)
- ❑ Total 20dB up at around 2 – 7kHz

### 1) Human Hearing Range?

# Middle Ear

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## ❖ Mechanics

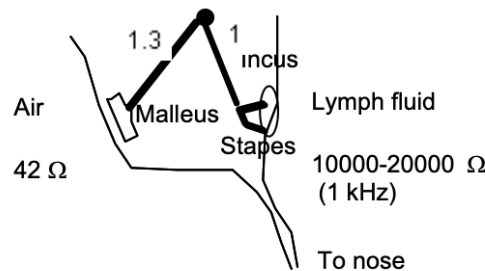
❑ Impedance Matching between air and lymph fluid

❖ Length: 1.3:1 leverage

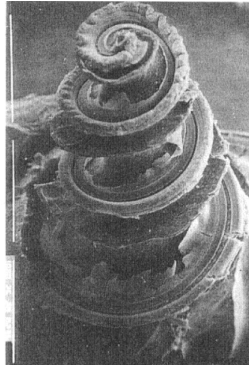
❖ Size: 35:1 → Impedance matching with ratio 20:1

❖ Impedance ratio due to deformation effect → 185:1

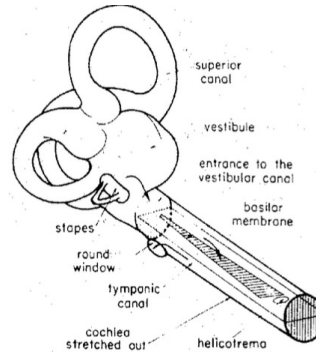
❖ Frequency response: attenuated in lower and higher freq.



# Inner Ear



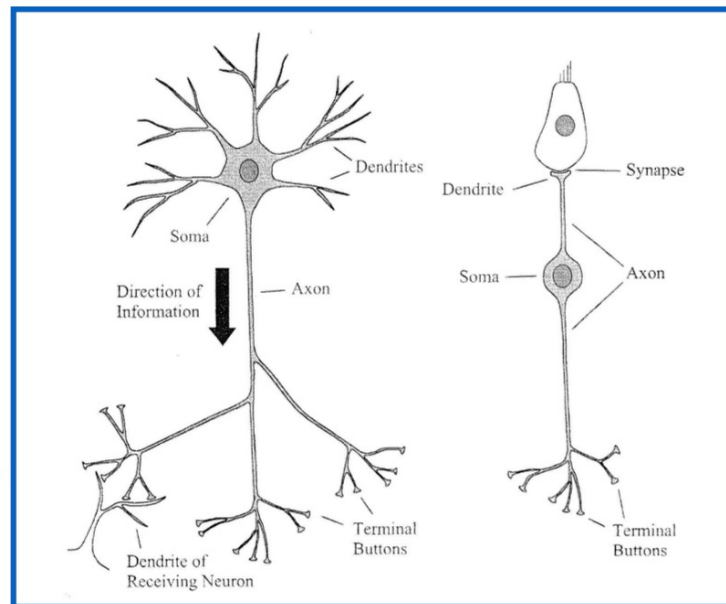
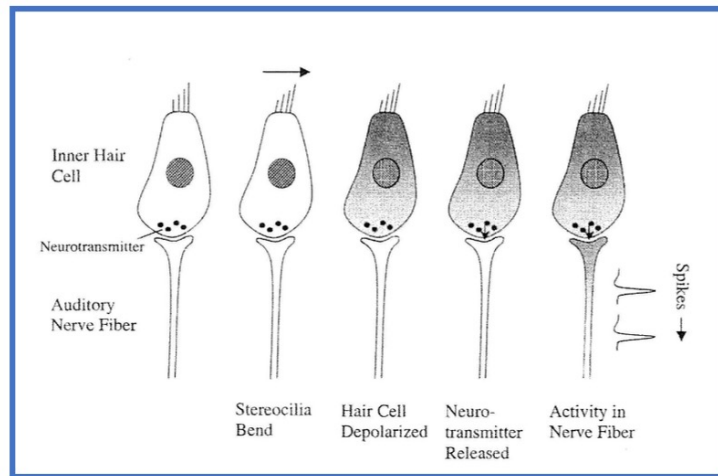
Cochlea of guinea pig



- ❖ Cochlea + semicircular canals.
- ❖ Cochlea: 2 and  $\frac{3}{4}$  anticlockwise rotation (human)
- ❖ Mechanics/Electronics
  - ❑ Vibration of stapes → Pressure difference in lymph fluid → Neural firing



# Auditory Nerve



❖ Stereocilia bend → Hair cell depolarized → Neuro-transmitter released → Activity in Nerve fiber

# Attributes of sound

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## ❖ Loudness

- ❑ Related to sound intensity

## ❖ Pitch

- ❑ Related to frequency of sound

## ❖ Timbre

- ❑ Related to spectrum structure

# Loudness

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- ❖ The subjective magnitude of a quantity scales with the power of the physical magnitude of that quantity.

# Pitch

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- ❖ The higher the frequency, the higher the sound
  - ❑ The pitch has the property of being linear with respect to frequency
  - ❑ The linear property is called Tone Height
- ❖ Pitch also has a cyclical nature
  - ❑ When the frequency is raised or lowered, a property like that of the original sound is perceived at one octave from the original sound
  - ❑ The cyclical property is called Tone Chroma

# Timbre

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- ❖ *“Timbre is one of the attributes of sound related to hearing, when two physically different sounds sound different, even if they have the same loudness and pitch. Timbre is the attribute corresponding to the difference.”*
- ❖ In this definition, all attributes other than loudness and pitch are included in the timbre.

# Hearing Loss

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# Hearing Loss

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## 2) Why does aging lead hearing loss?

# Hearing

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**3) Why are high frequency components  
used for alarm signals?**



# Homework 2

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Answer (1), (2), and (3)