

# M.Sc. LST

## Speech Science

Auditory system

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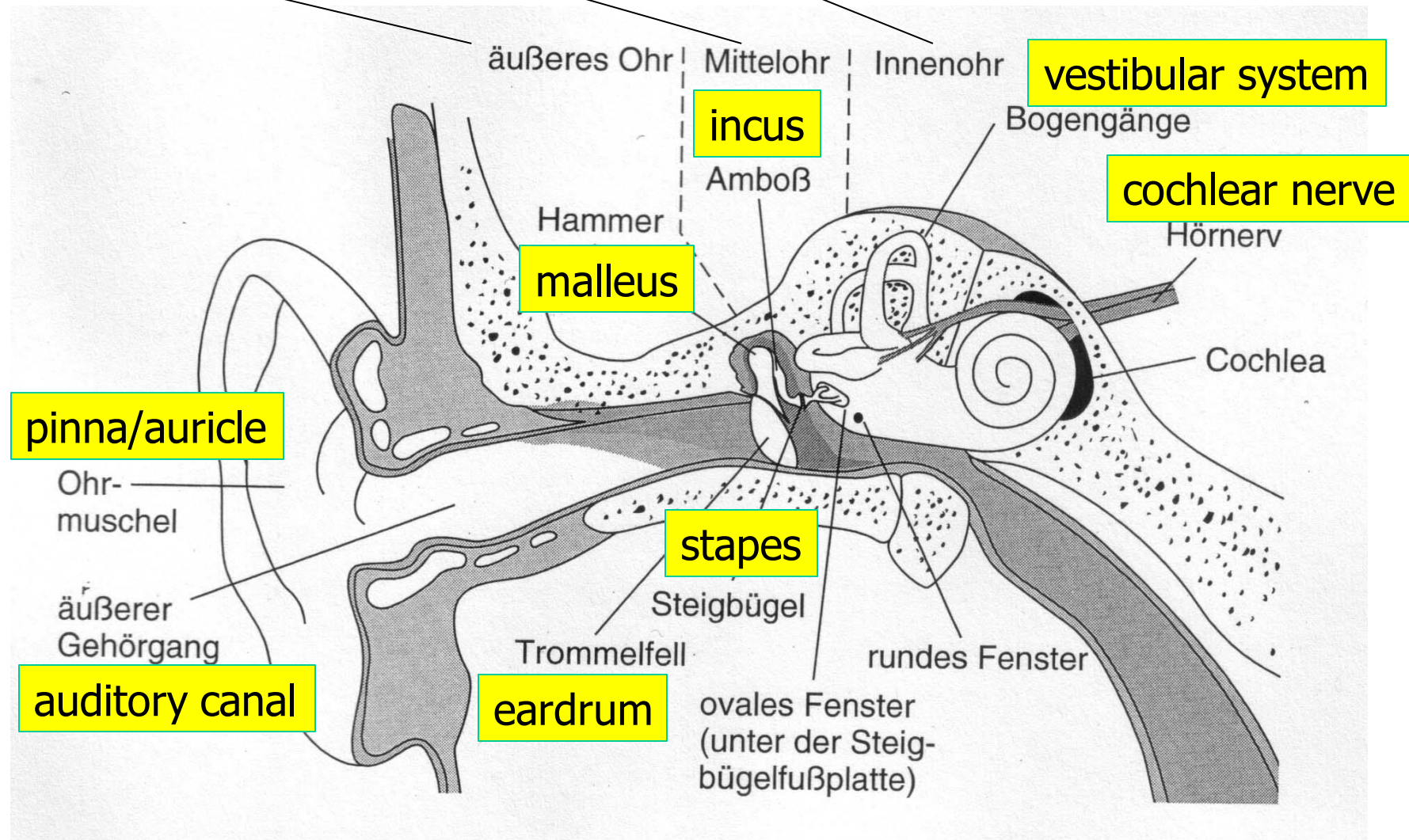
# Overview

- Anatomy and physiology of the auditory system
- Speech perception
  - auditory perception
  - psychoacoustics
  - auditory-perceptual phonetics

# Audition and speech perception

- Audition / listening: auditory system converts sound (i.e. air pressure changes) to neural impulses
  - perception within frequency range relevant to speech
  - filtering out irrelevant background noise
  - adaptation to idiosyncratic properties of speaker
- Speech perception / understanding: interpretation of neural signals as speech events
  - decoding and segmentation into meaningful elements
  - association of identified elements with mental representations
  - association of recognized representations with semantic concepts

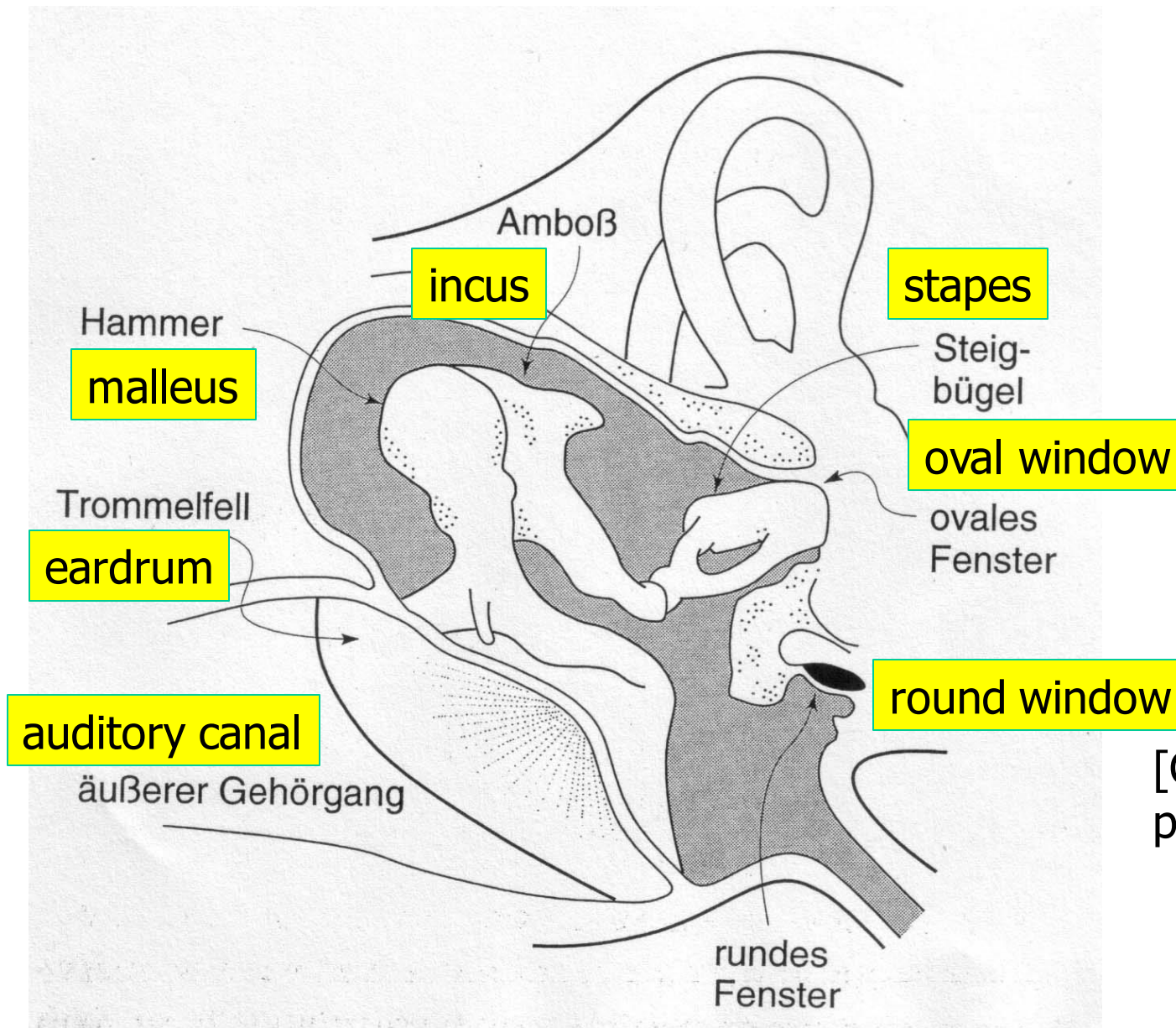
# Outer ear, middle ear, inner ear



[Goldstein, 1997, p.322]

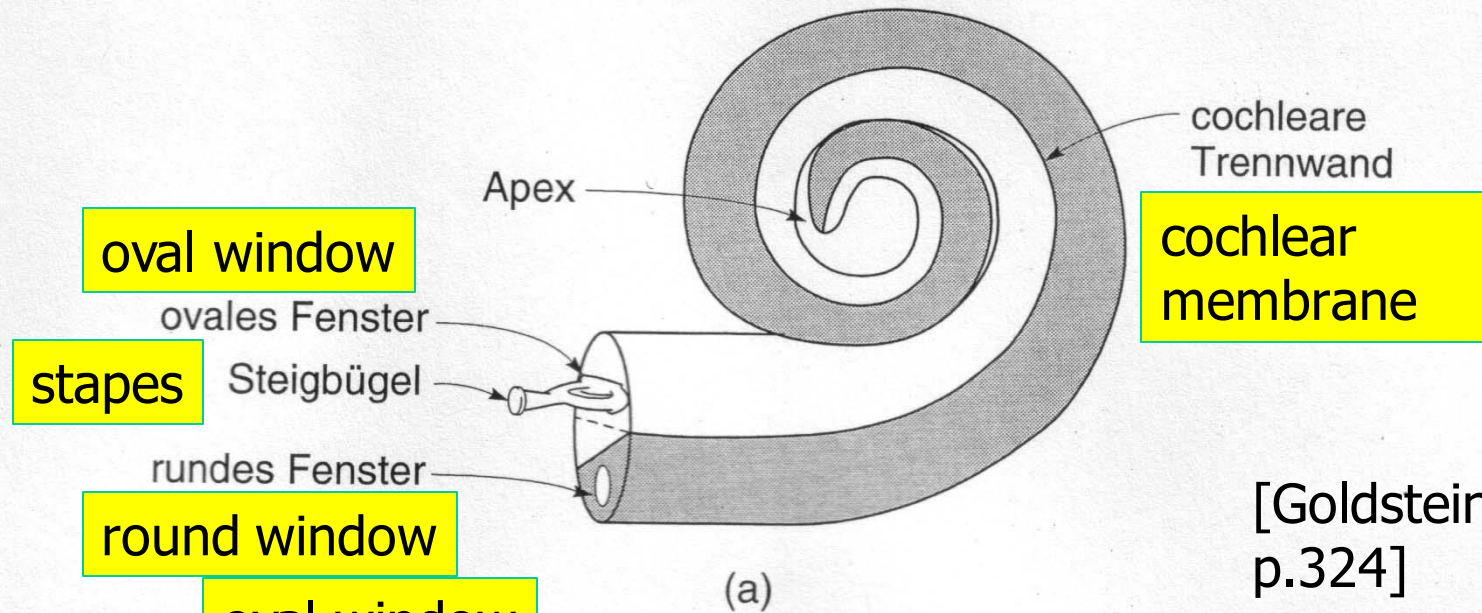


# Middle ear

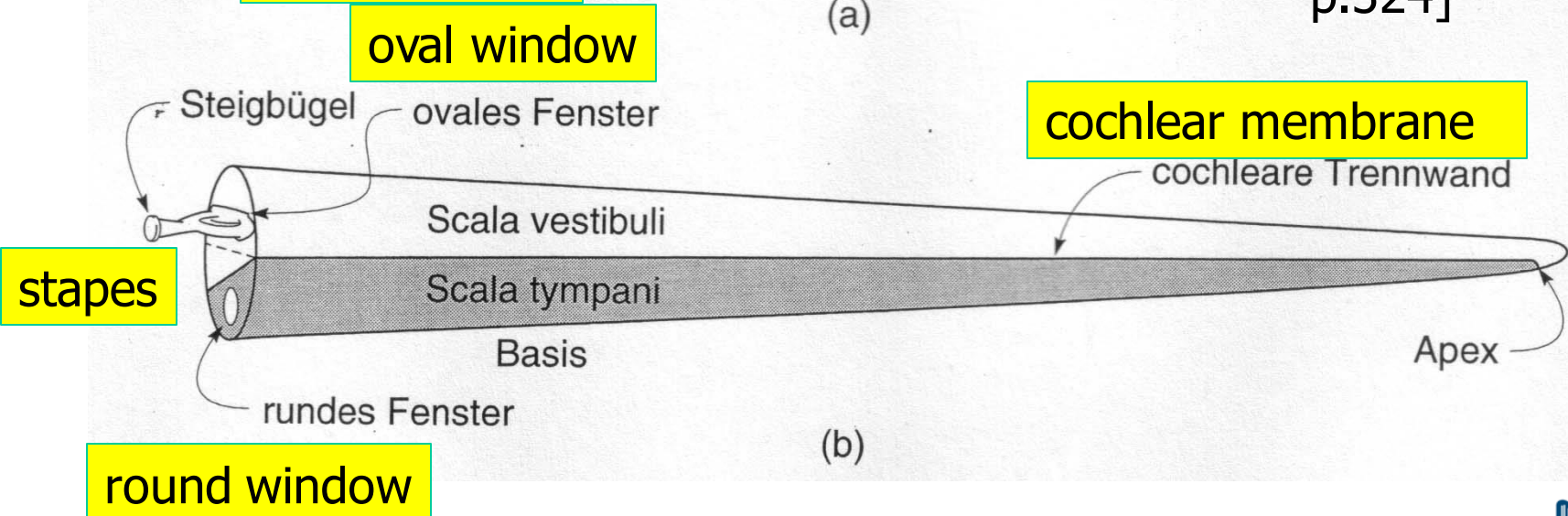


[Goldstein, 1997, p.322]

# Cochlea

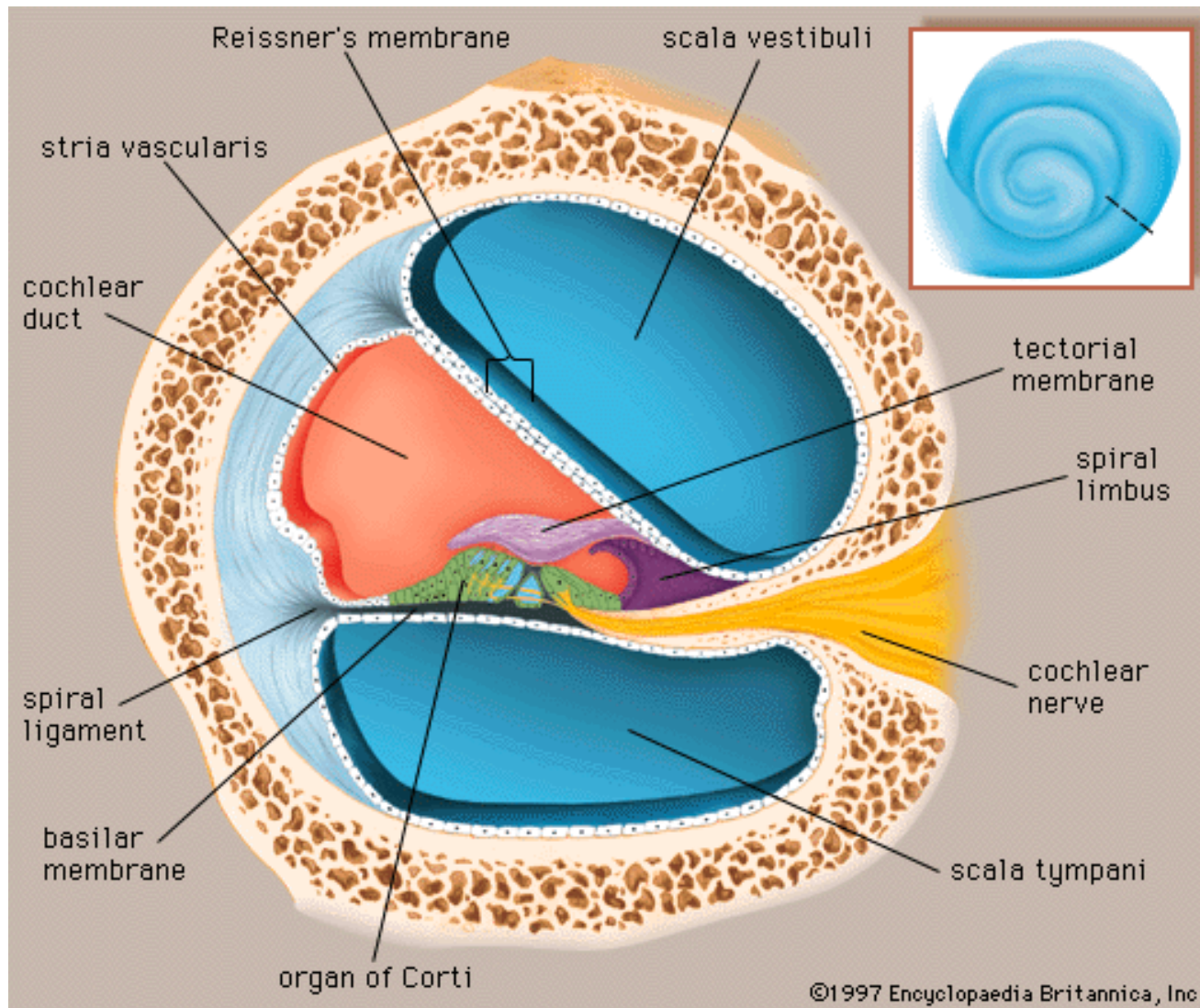


[Goldstein, 1997, p.324]



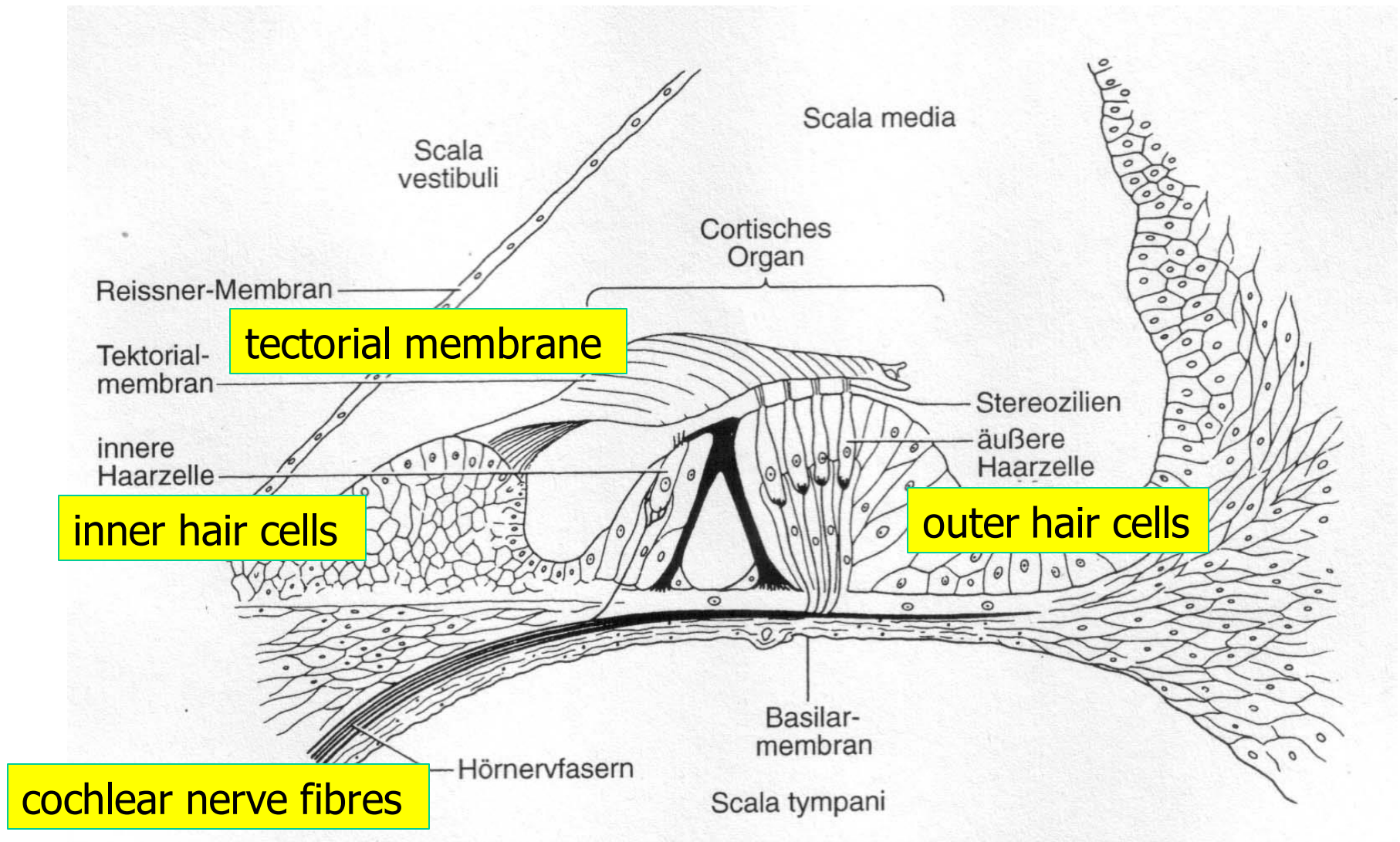


# Cochlea



[<http://www.britannica.com/EBchecked/media/534/A-cross-section-through-one-of-the-turns-of-the>]

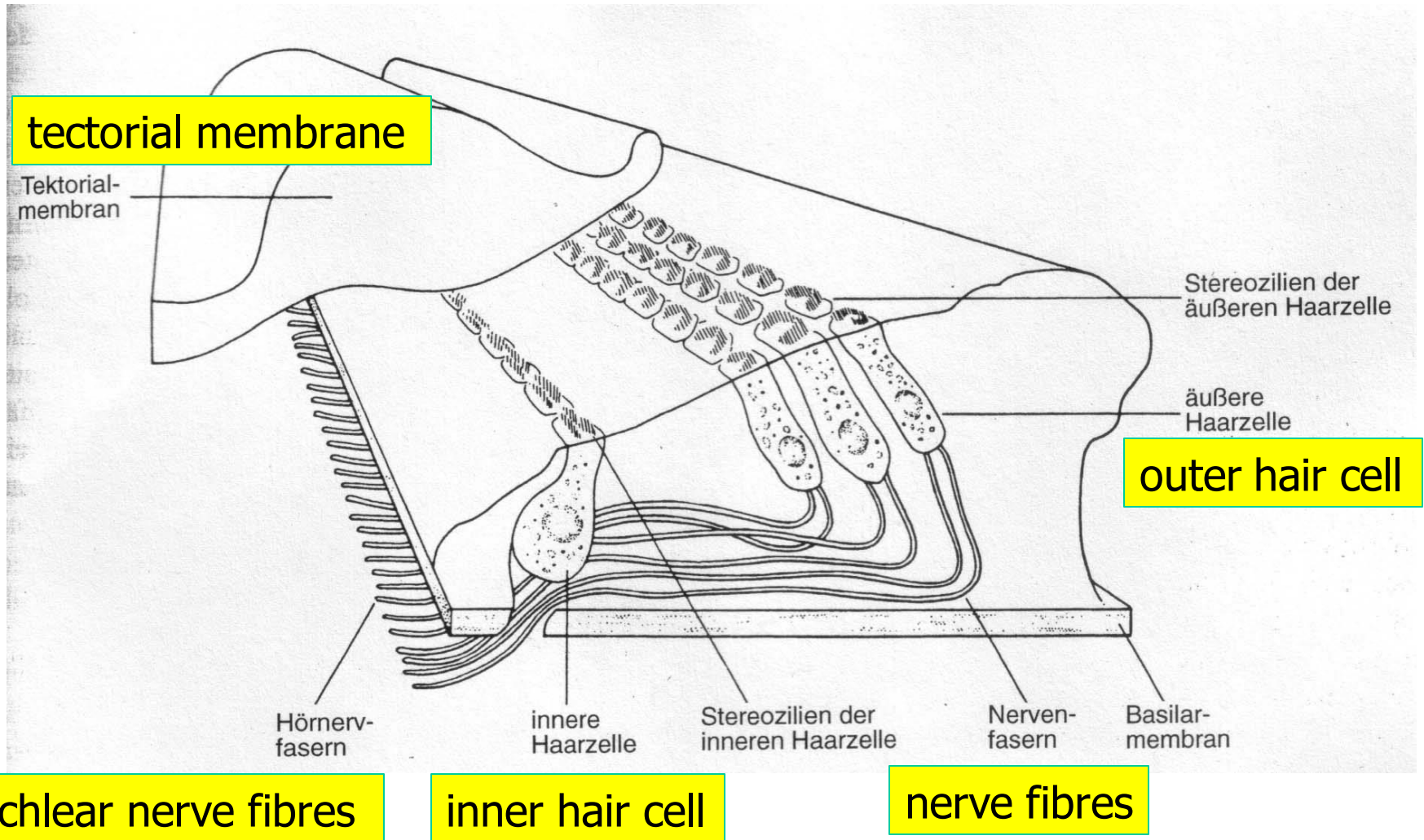
# Organ of Corti



[Goldstein, 1997, p.325]



# Organ of Corti



[Goldstein, 1997, p.325]

# Auditory system: overview

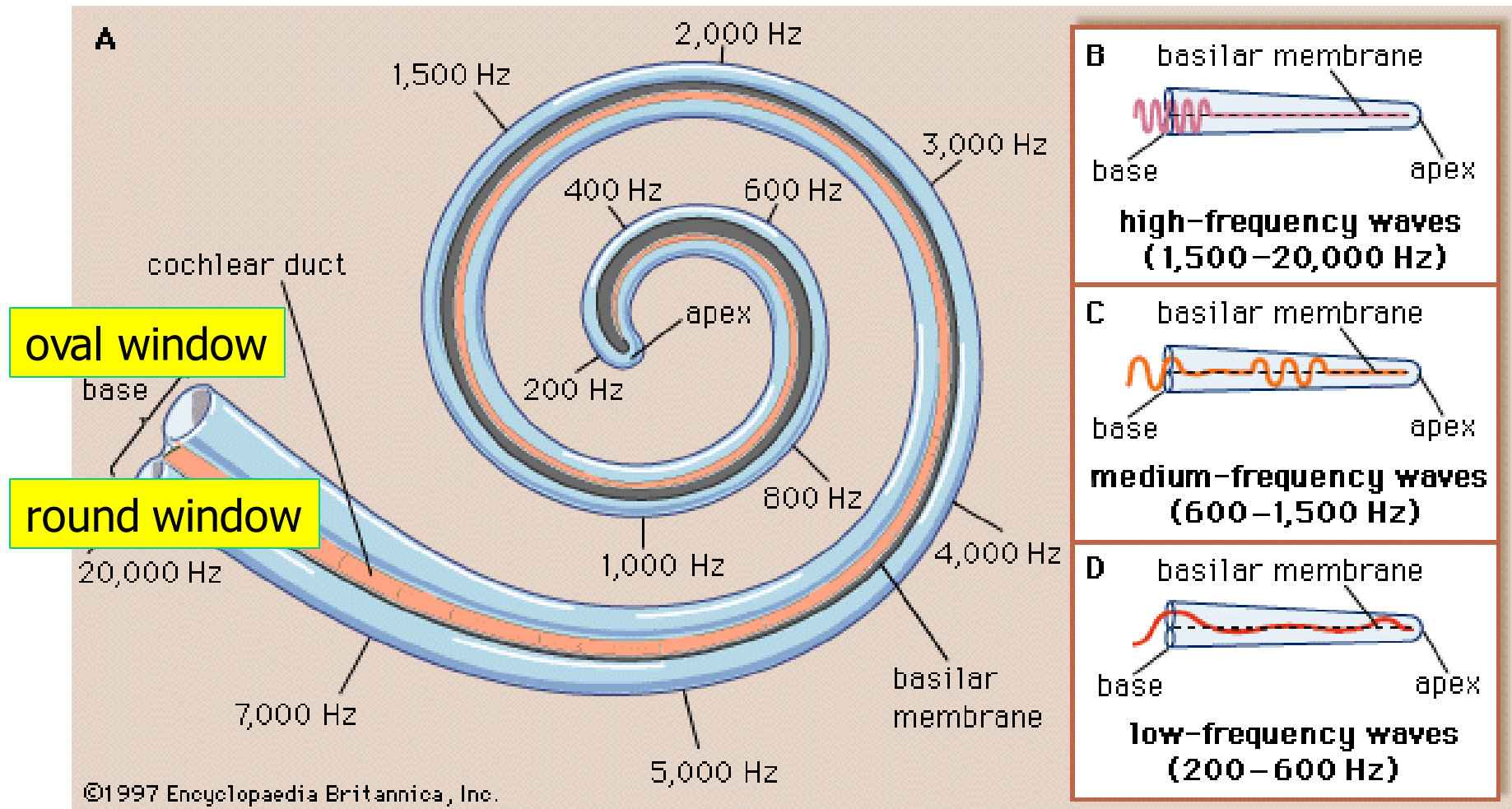
	Component	Function
Outer ear	Pinna	Localization of sound source
	Auditory canal	Protection; enhance 2 – 4 kHz
	Eardrum (tympanic membrane)	Register sound pressure changes
Middle ear	Ossicles (malleus, incus, stapes)	Reinforce eardrum vibrations
	Oval window	Interface air → fluid
Inner ear	Scala vestibuli, tympani, media	Container of perilymph (sc.v./t.), endolymph (sc.m.)
	Organ of Corti, with bas./tect. membranes, inner/outer hair cells	Register fluid pressure changes, spectral analysis, transformation to neural signals

# From sound to neural signals

- air pressure changes → vibrations → oval window
- vibrations → fluid movements
- perilymph movements → standing waves in cochlea → **spatial encoding of frequency components**
- elicitation of hair cells of organ of Corti
- hair cells comprises approx. 100 cilia (stereocilia)
- movement of cilia causes emission of chemical neurotransmitter (glutamate) to primary auditory neurons
- auditory nerve fibres transmit resulting electrophysiological signal to primary auditory cortex

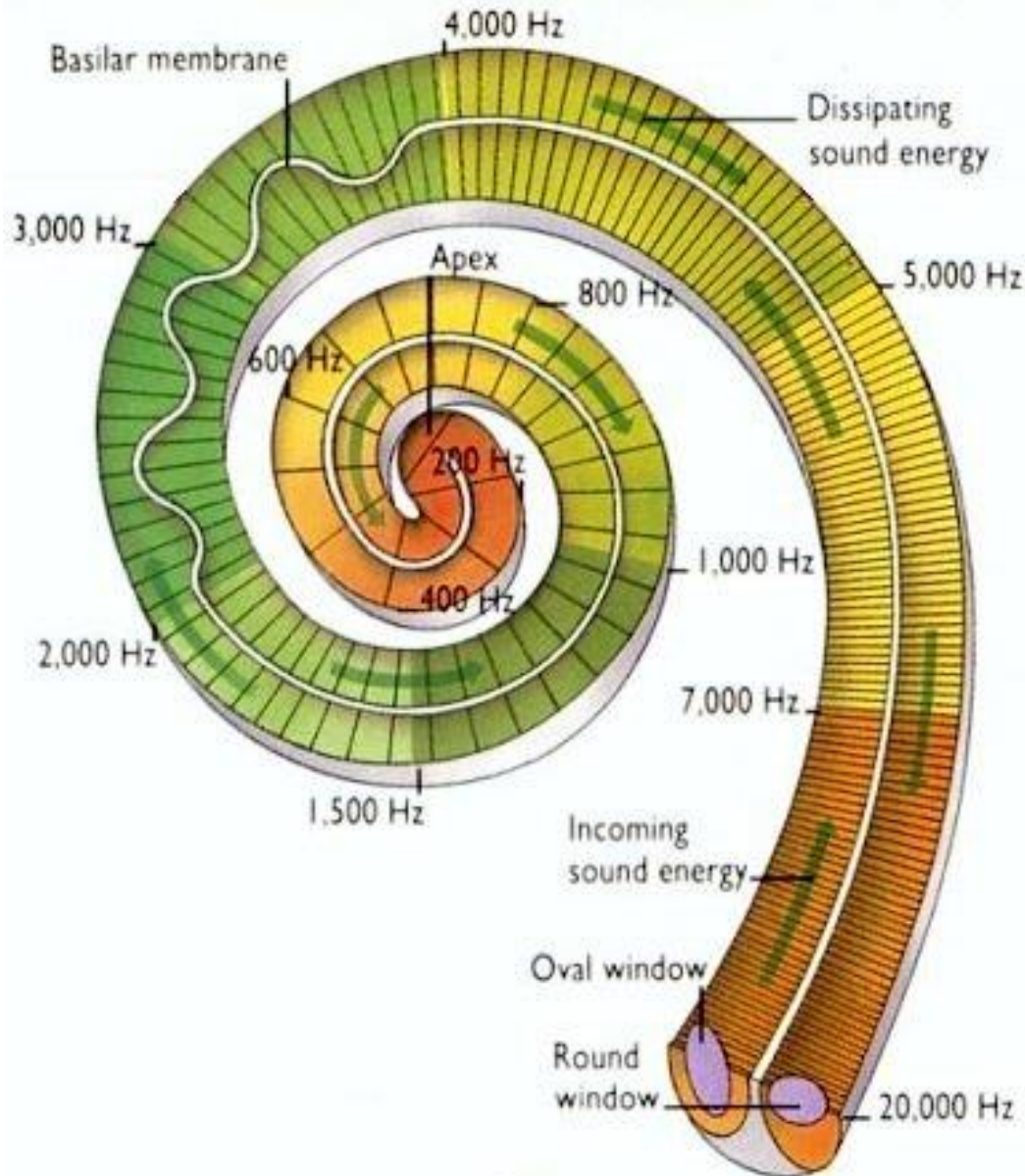


# Spatial encoding of frequency components



[<http://teddysratlab.blogspot.com/2011/03/and-ears-to-hear.html>]

# Spatial encoding of frequency components



[<http://universe-review.ca/I10-85-cochlea2.jpg>]

# Connections in auditory system

auditory cortex (in temporal lobe)

auditorischer Cortex  
(im Schläfenlappen)

Colliculus inferior

Cochlea

Nucleus geni-  
culatum mediale

Nucleus cochlearis

obere Olive

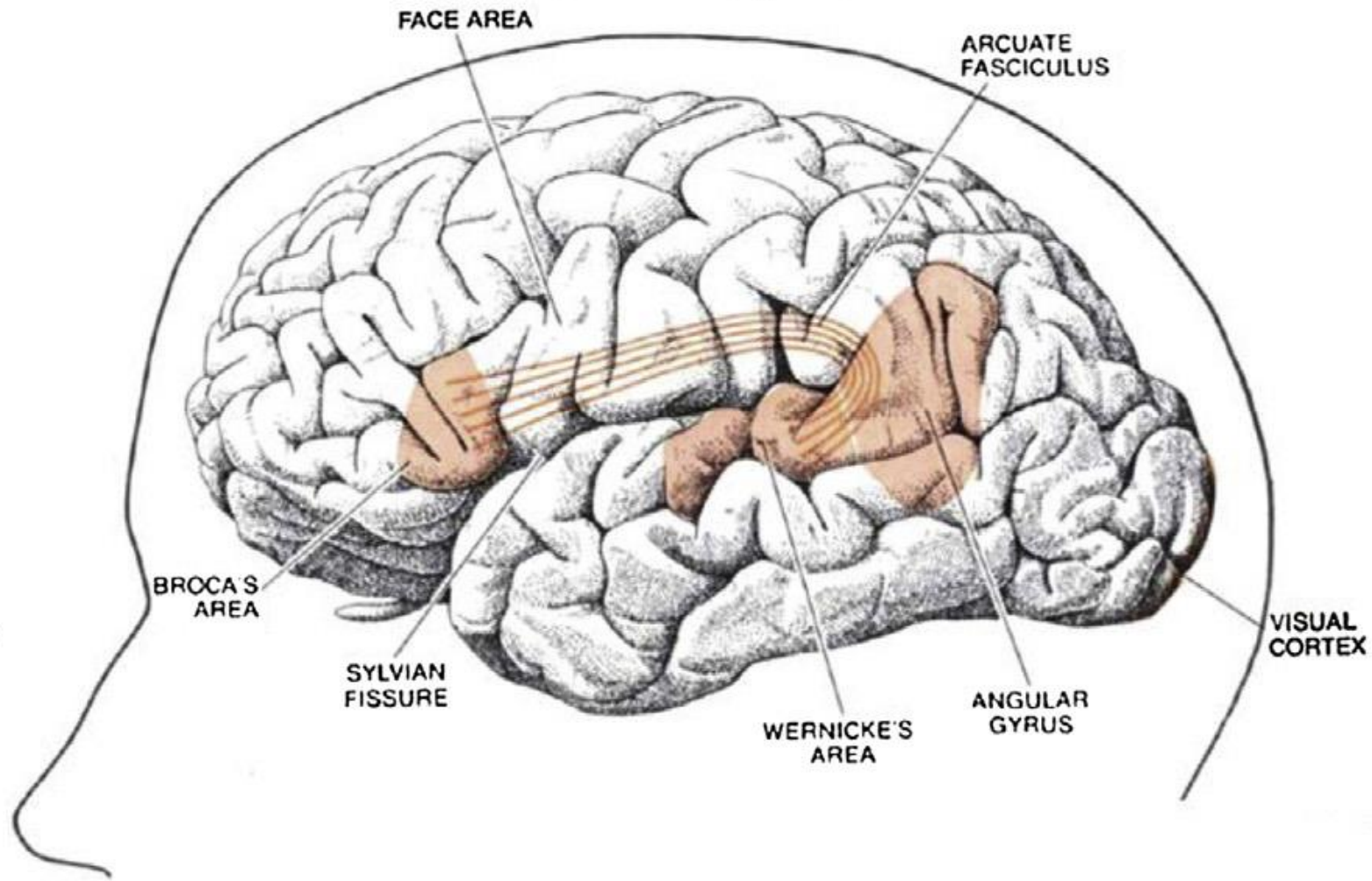
superior olivary complex

[Goldstein, 1997, p.327]



# Language areas in the brain

Geschwind, 1972



Thanks!

