

M.Sc. LST

Speech Science

Auditory system

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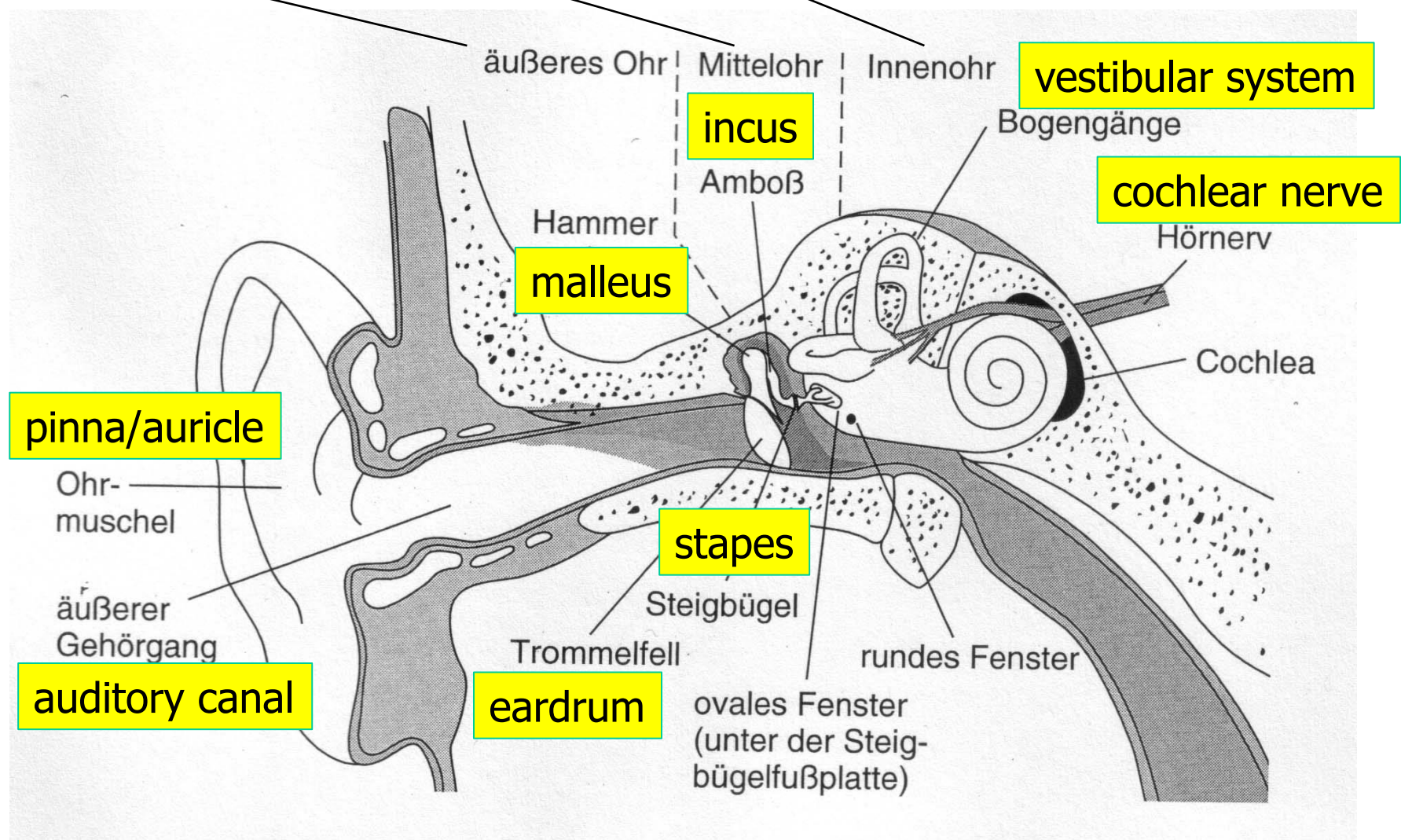
Overview

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

Audition and speech perception

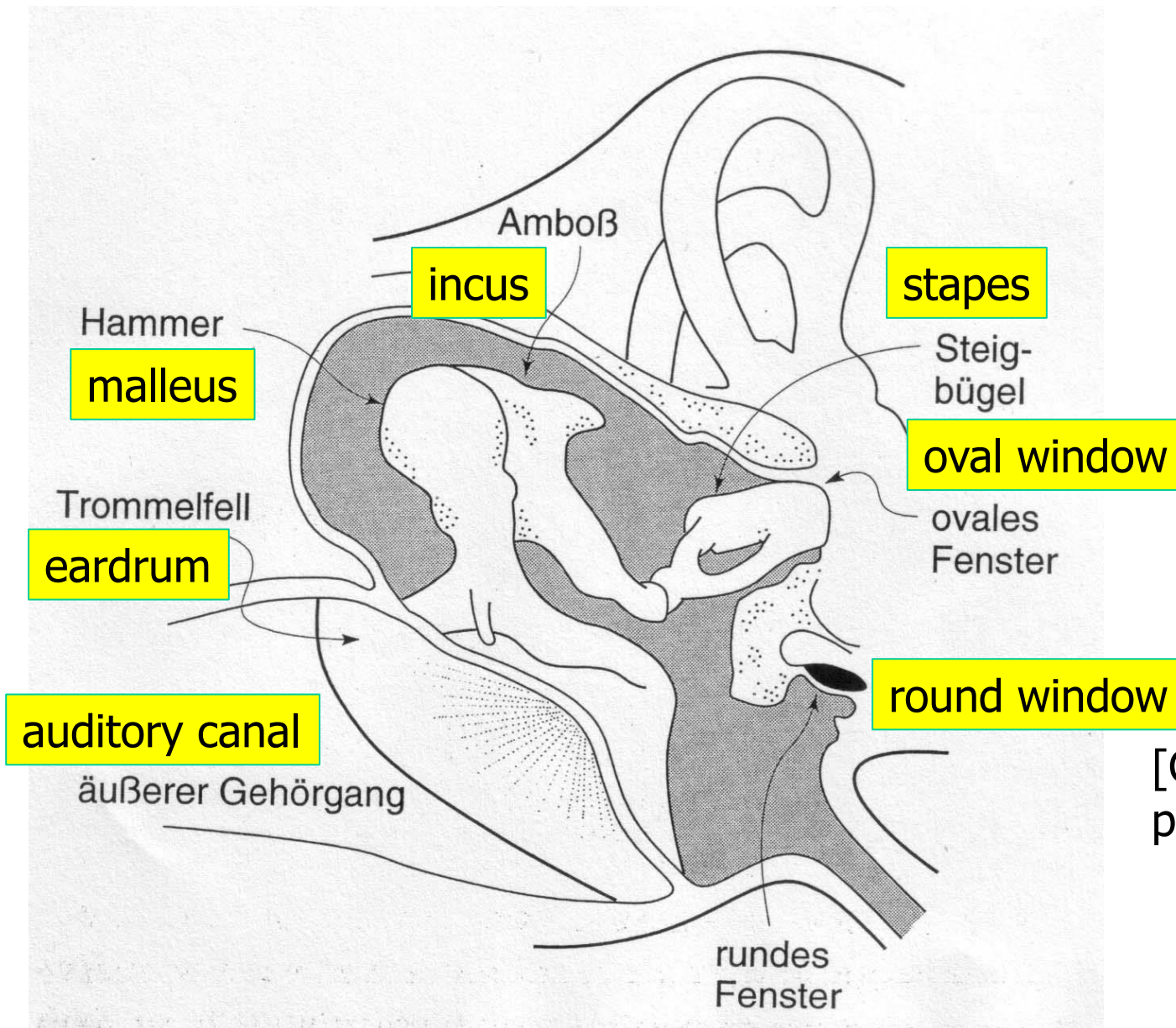
- Audition / listening: auditory system converts sound (i.e. air pressure changes) to neural impulses
 - perception within frequency range relevant to speech
 - filtering out irrelevant background noise
 - adaptation to idiosyncratic properties of speaker
- Speech perception / understanding: interpretation 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

oval window

stapes

round window

oval window

stapes

round window

Apex

cochleare
Trennwand

cochlear
membrane

ovales Fenster

Steigbügel

rundes Fenster

(a)

[Goldstein, 1997,
p.324]

cochlear membrane

cochleare Trennwand

Scala vestibuli

Scala tympani

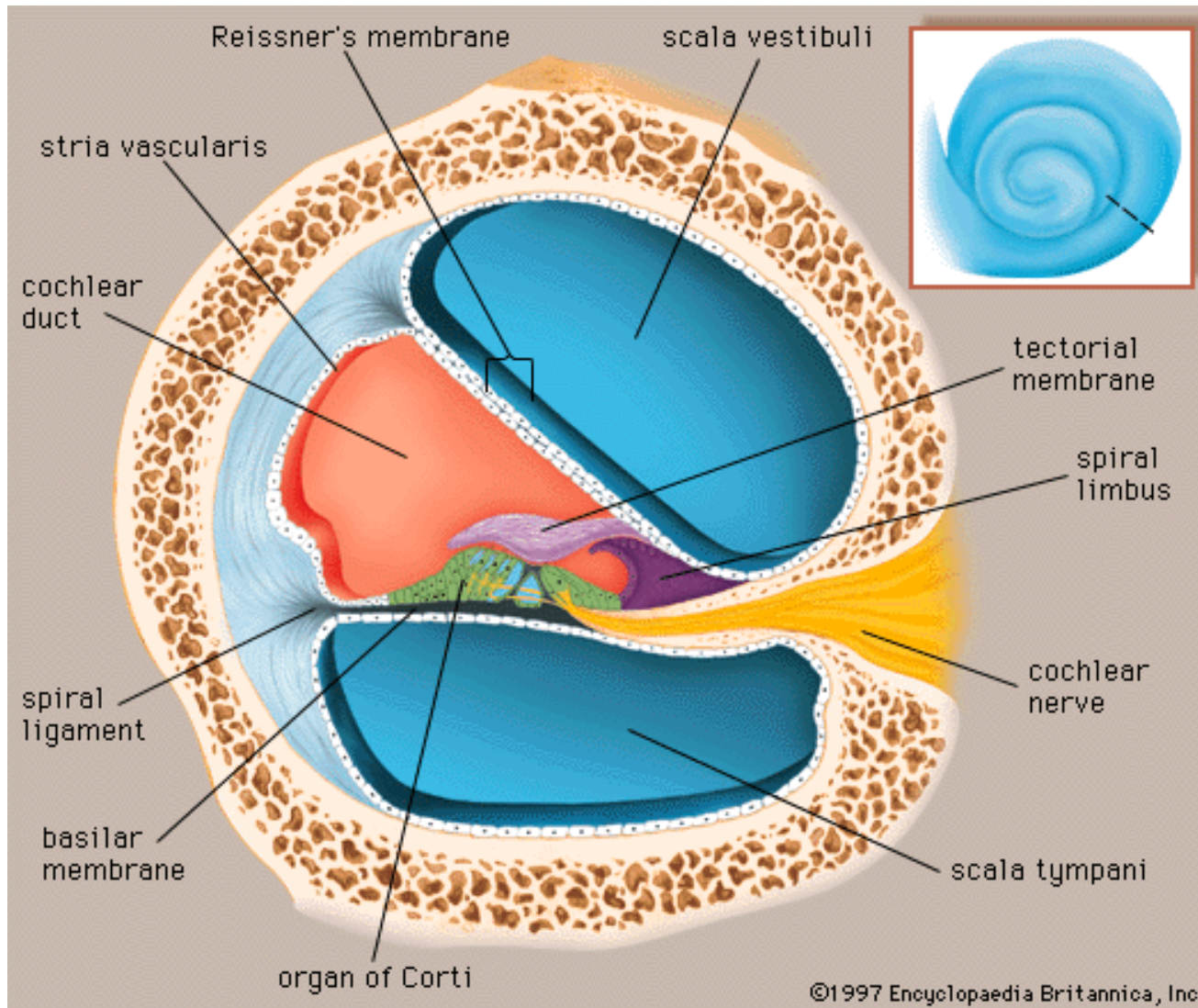
Basis

rundes Fenster

Apex

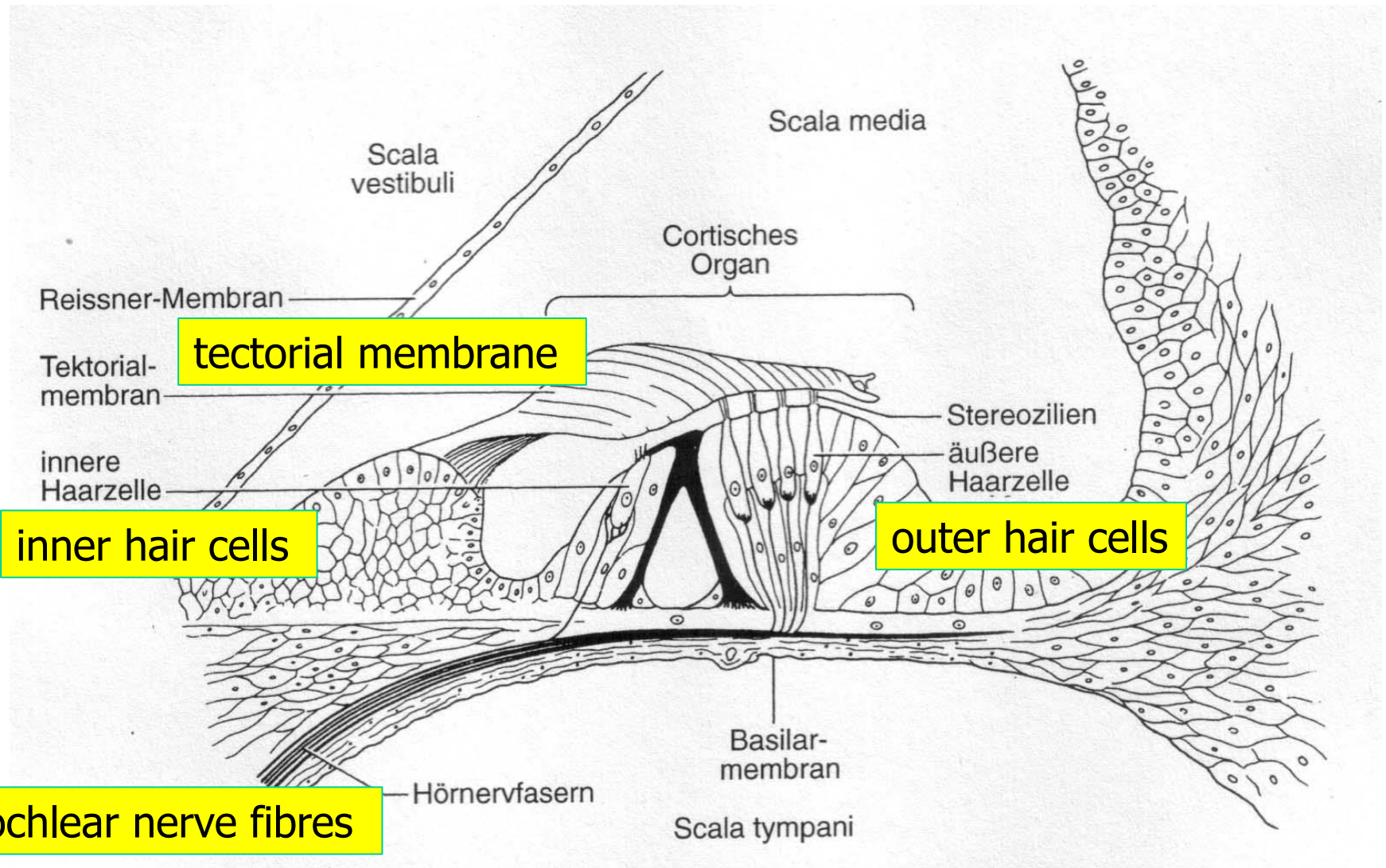
(b)

Cochlea



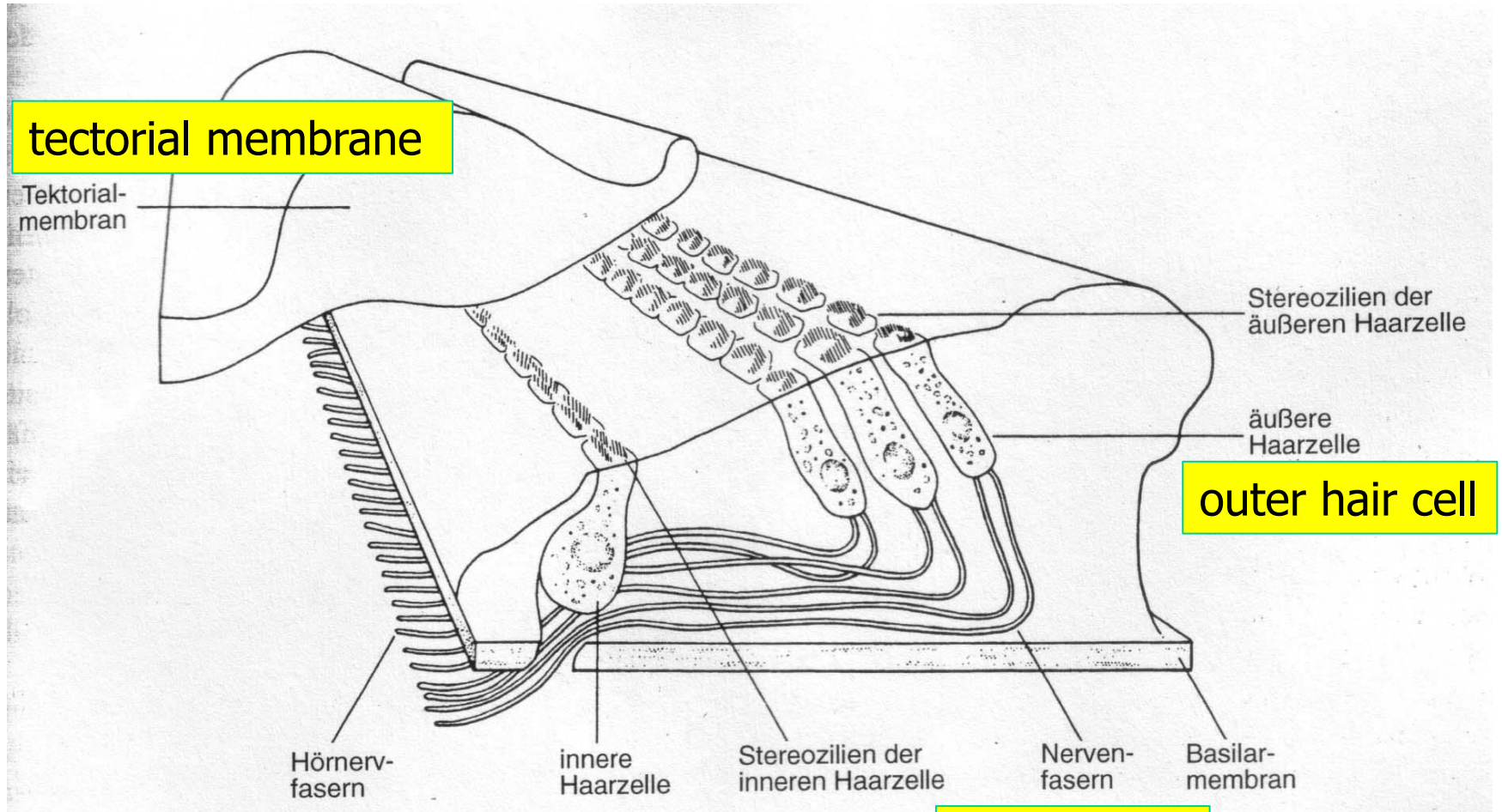
[<http://www.britannica.com/EBchecked/media/534/A-cross-section-through-one-of-the-turns-of-the>]

Organ of Corti



[Goldstein, 1997, p.325]

Organ of Corti



tectorial membrane

Tektorial-membran

Stereozilien der äußeren Haarzelle

äußere Haarzelle

outer hair cell

Hörnerv-fasern

innere Haarzelle

Stereozilien der inneren Haarzelle

Nerven-fasern

Basilar-membran

cochlear nerve fibres

inner hair cell

nerve fibres

[Goldstein, 1997, p.325]

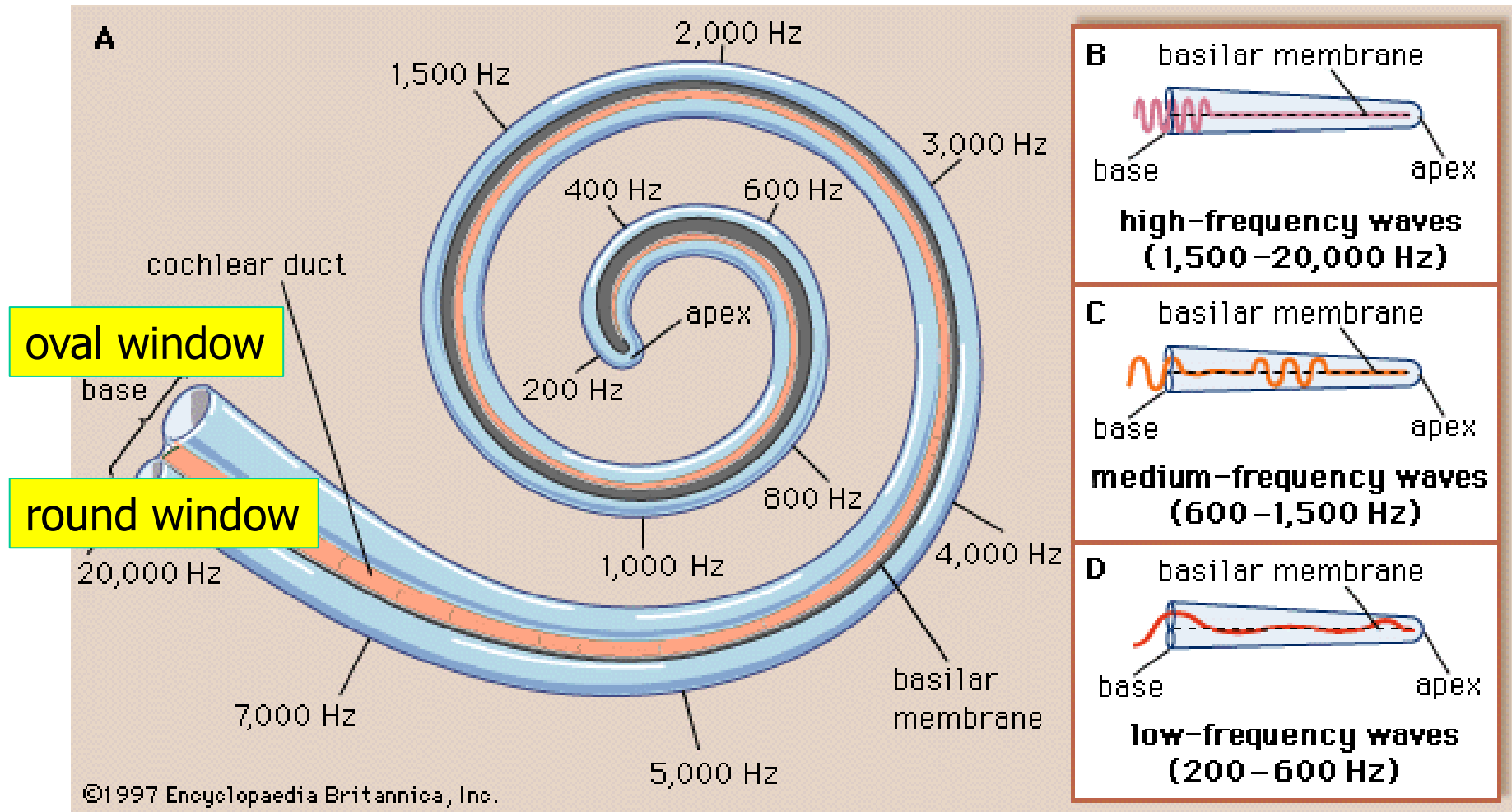
Auditory system: overview

	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

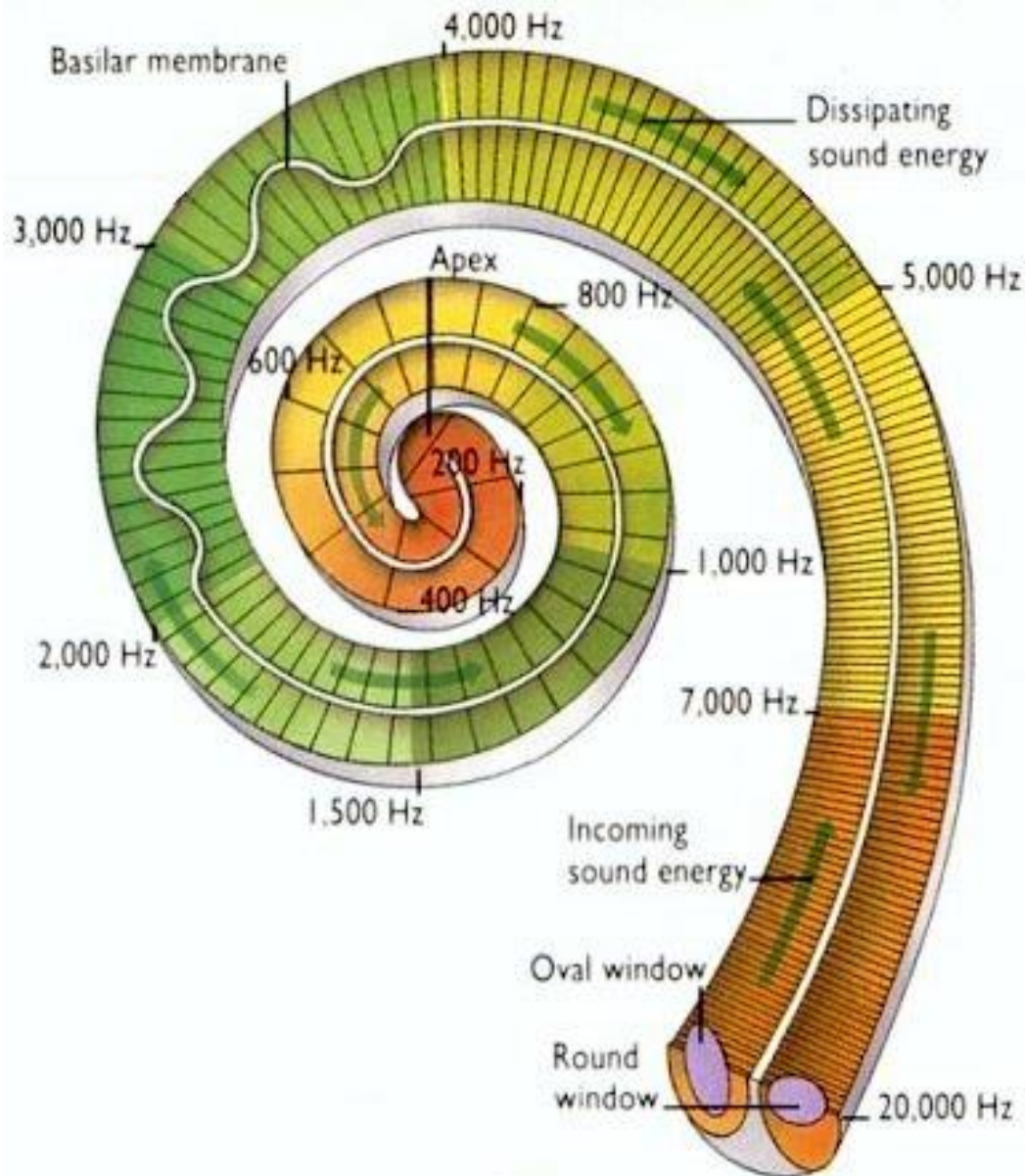
- air pressure changes → vibrations → oval window
- vibrations → fluid movements
- perilymph movements → standing waves in cochlea → **spatial encoding of frequency components**
- elicitation of hair cells of organ of Corti
- hair cells comprises approx. 100 cilia (stereocilia)
- movement of cilia causes 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

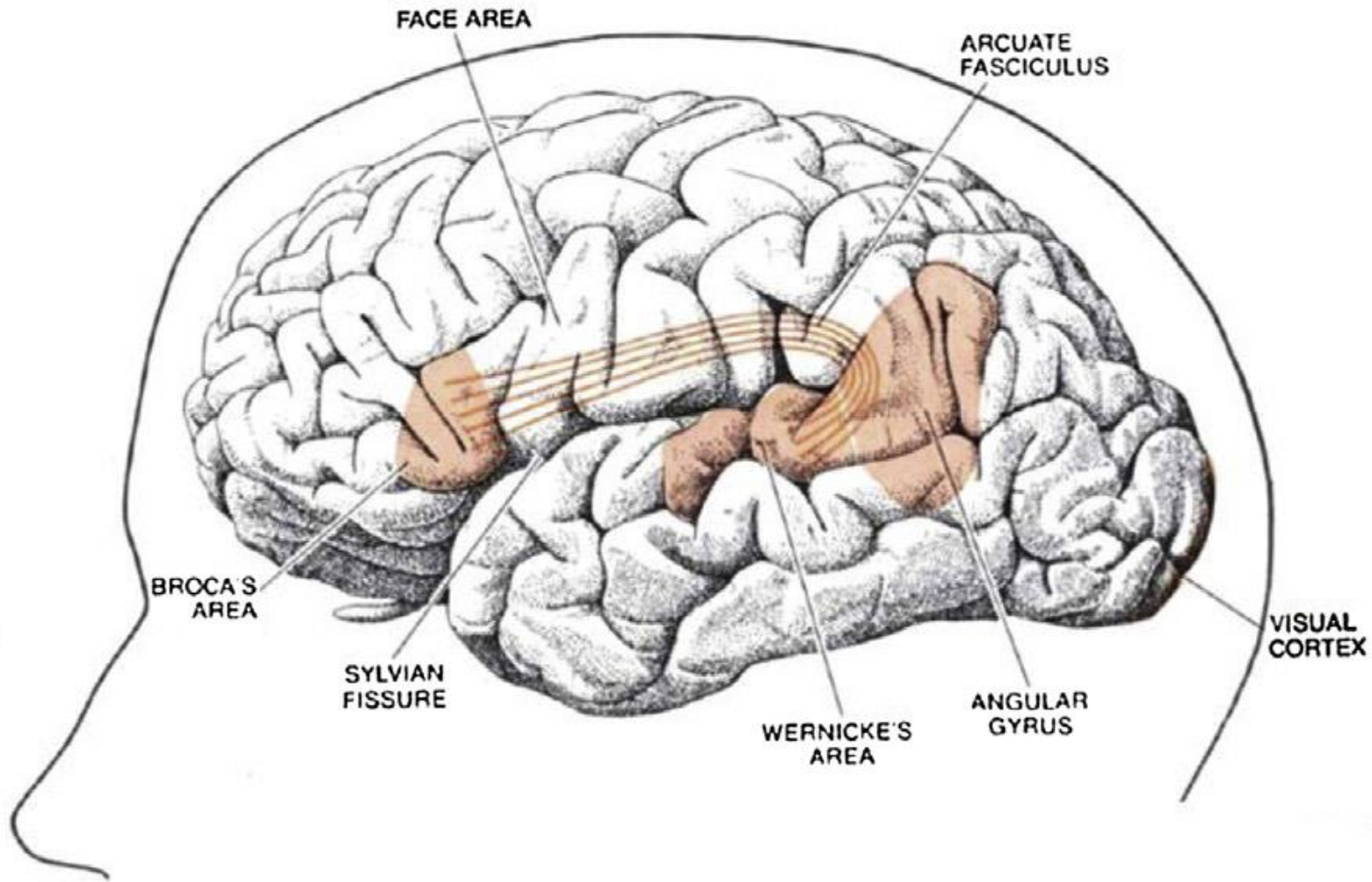
obere Olive

superior olivary complex

[Goldstein, 1997, p.327]

Language areas in the brain

Geschwind, 1972



Thanks!

