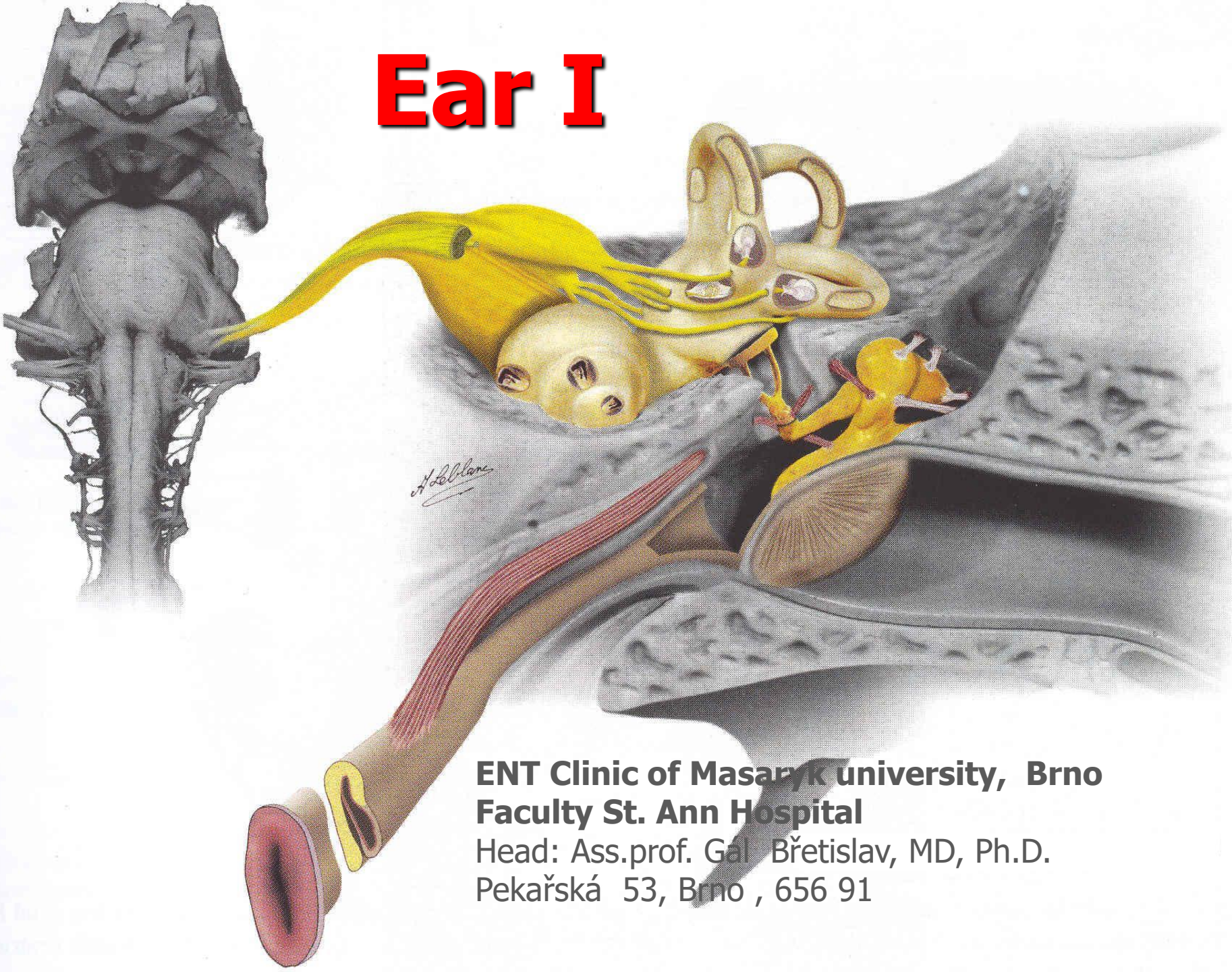
Literature:

Hans Behrbohm, Oliver Kaschke, Tadeus Nawka,Andrew Swift: **Ear, Nose, and Throat Diseases**: Founding Authors W. Becker, H.H. Naumann, C.R. Pfaltz (Paperback) Publisher: Thieme Publishing Group; 3rd Revised edition edition (12 Aug 2009). 471 pages , Language English. ISBN-10: 313671203X, ISBN-13: 978-3136712030.

Med Servis Mgr. Jaroslava Wilhelmová, Všetičkova 29, 602 00 Brno. Tel./fax. 05/43241146 .

Ear I



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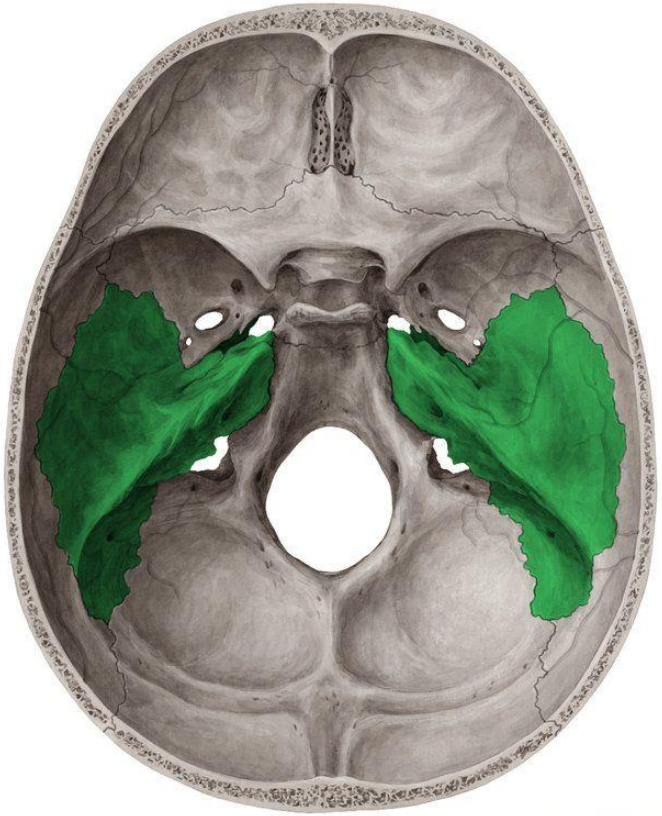
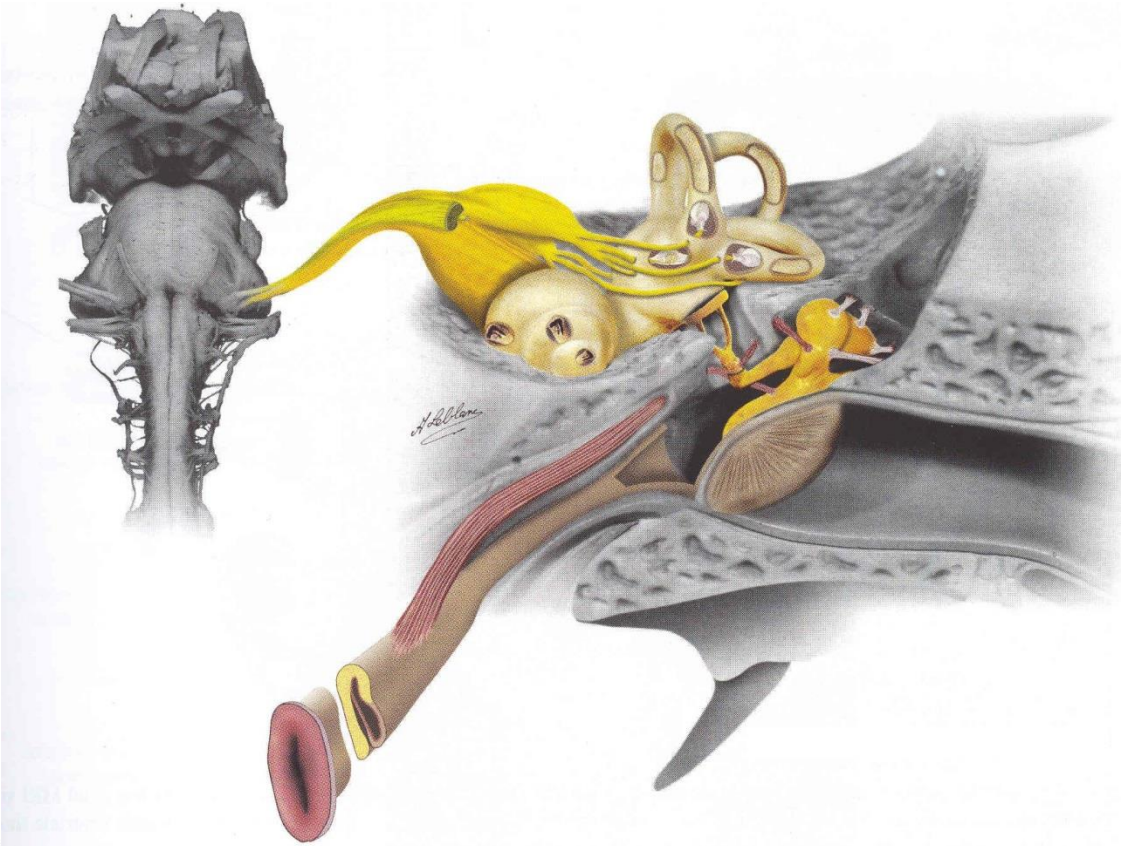
The hearing and balance system

The hearing and balance system localized in temporal bone





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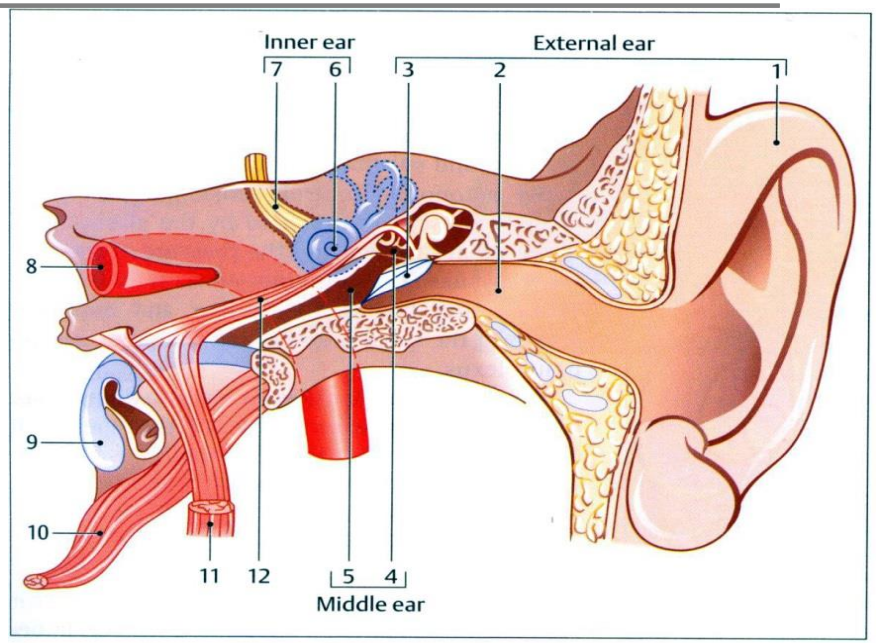
The hearing and balance system



Two main subdivisions:

Peripheral Part

- external, middle and inner ear
- auditory nerve

Central Part

- central hearing pathways
- subcortical and cortical auditory centers
- central balance mechanism

Anatomic boundary - entry the VIIth nerve into brainstem.

- The external and middle ear *transport* the stimulus
- cochlea *distributes* the stimulus
- the sensory cells *transform* the stimulus

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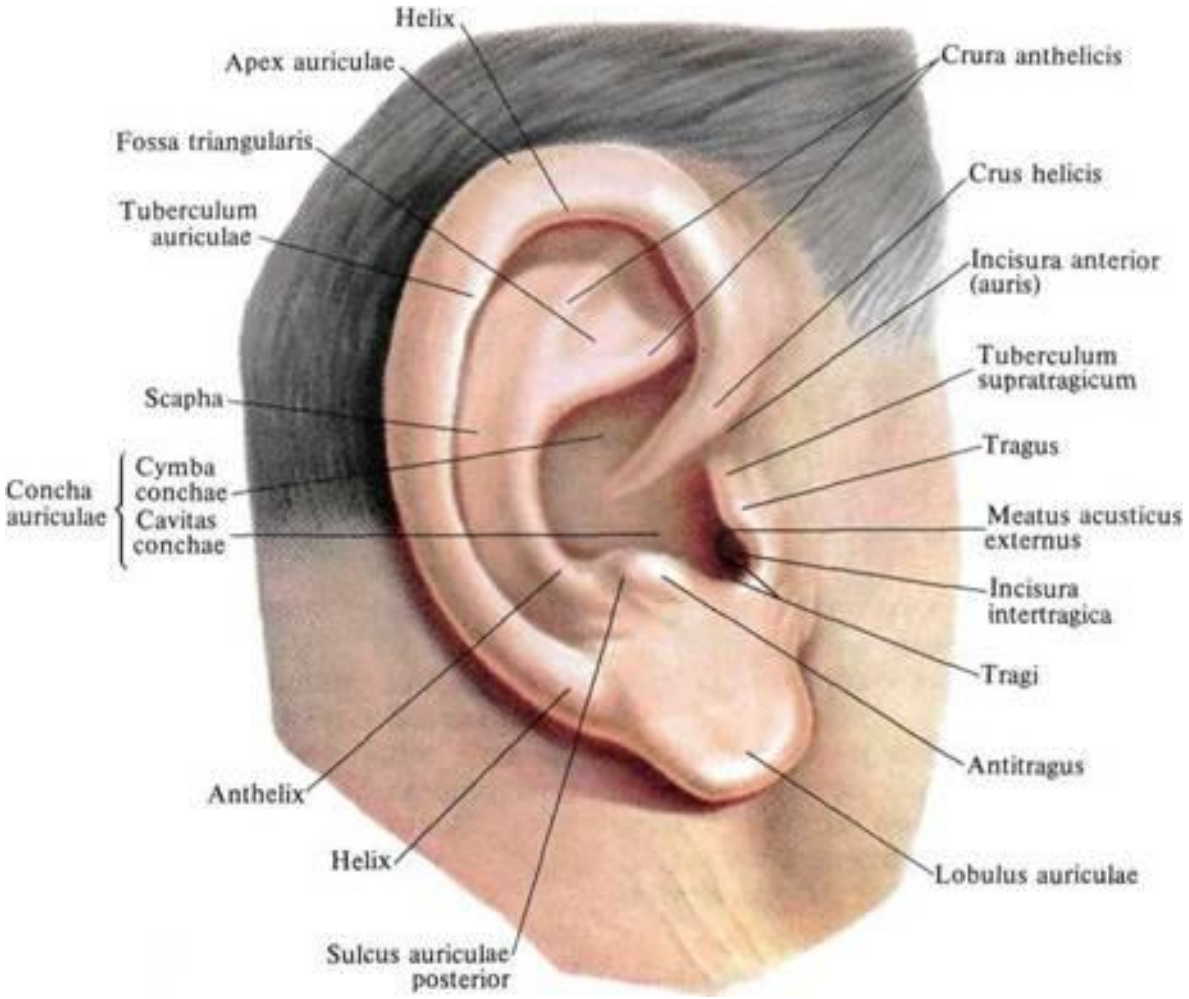
External ear

Auricle – abundantly formatted cartilage



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External meatus (meatus acusticus externus)

External part

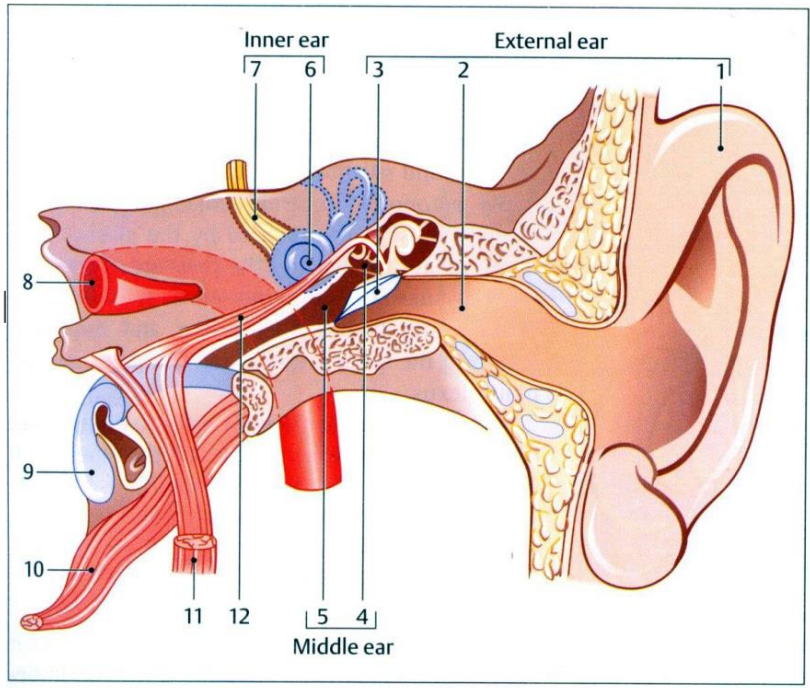
- cartilage
- Lined with skin and down (tragi) and sebaceous gland – cerumen

Internal part

- Temporal bone
- Lined with thinned epidermis

– curved cartilaginous mobile part – must be drawn upward and posteriorly – to bring the same axis

External meatus skin has 10x higher growth potential than middle ear linen – theory of development of acquired cholesteatoma



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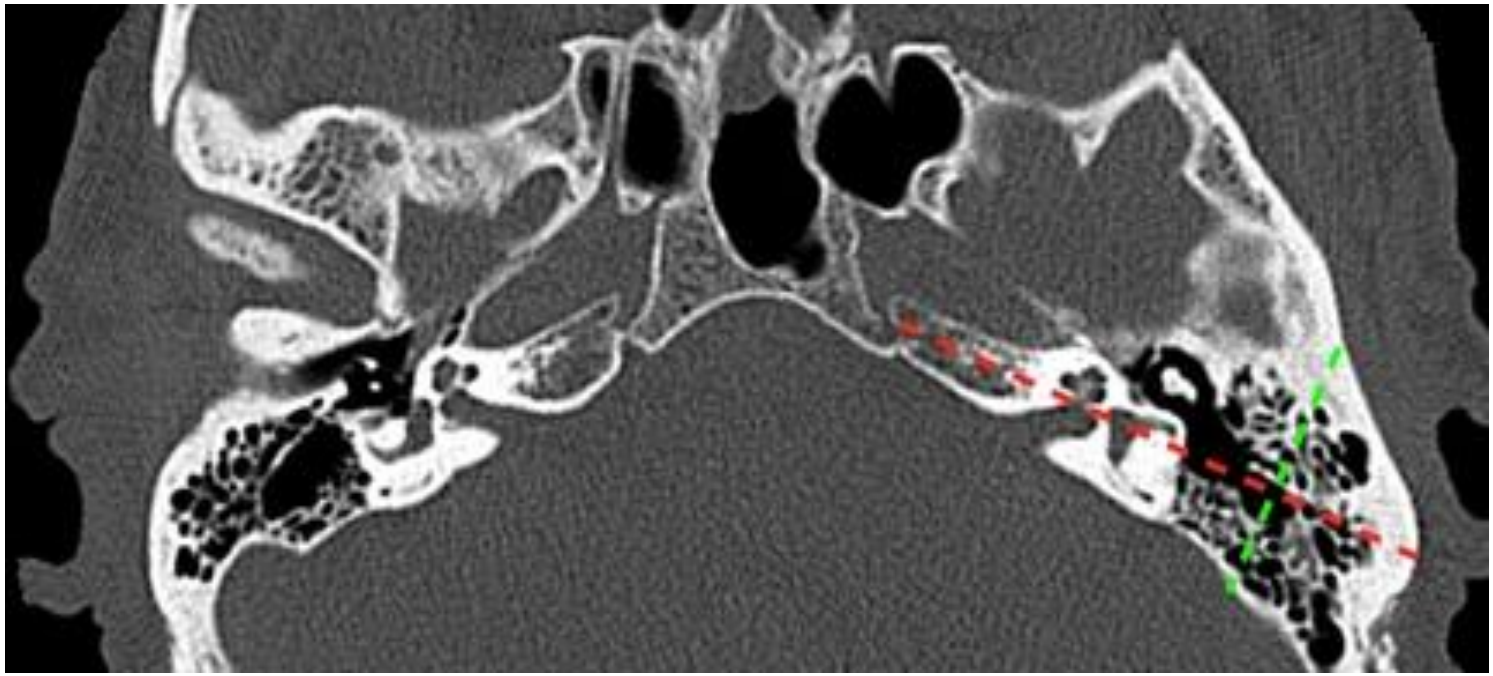
Middle Ear

Middle Ear cavity

- summary name for the whole pneumatic system of temporal bone: tympanic cavity, cells of proc. mastoideus and Eustachian tube (tubotympanal and tympanomastoideal segment)



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Middle Ear

Tympanic membrane (membrana tympani)

- a sound pressure receptor and transformer

Inclination and declination angle to meatus axis

surface 55 mm^2

- sulcus tympanicus
- anulus fibrocartilagineus

pars tensa

- *Three layers:*
  - external- epidermis (stratum cunateum)
  - middle– fibrouas layer ,str. fibrosum
  - internal– epitel, str. mucosum

pars flaccida (membrana Shrapnelli)

- Surface 5 mm^2 in superior part of ear drum
- Fibrous layer is missing

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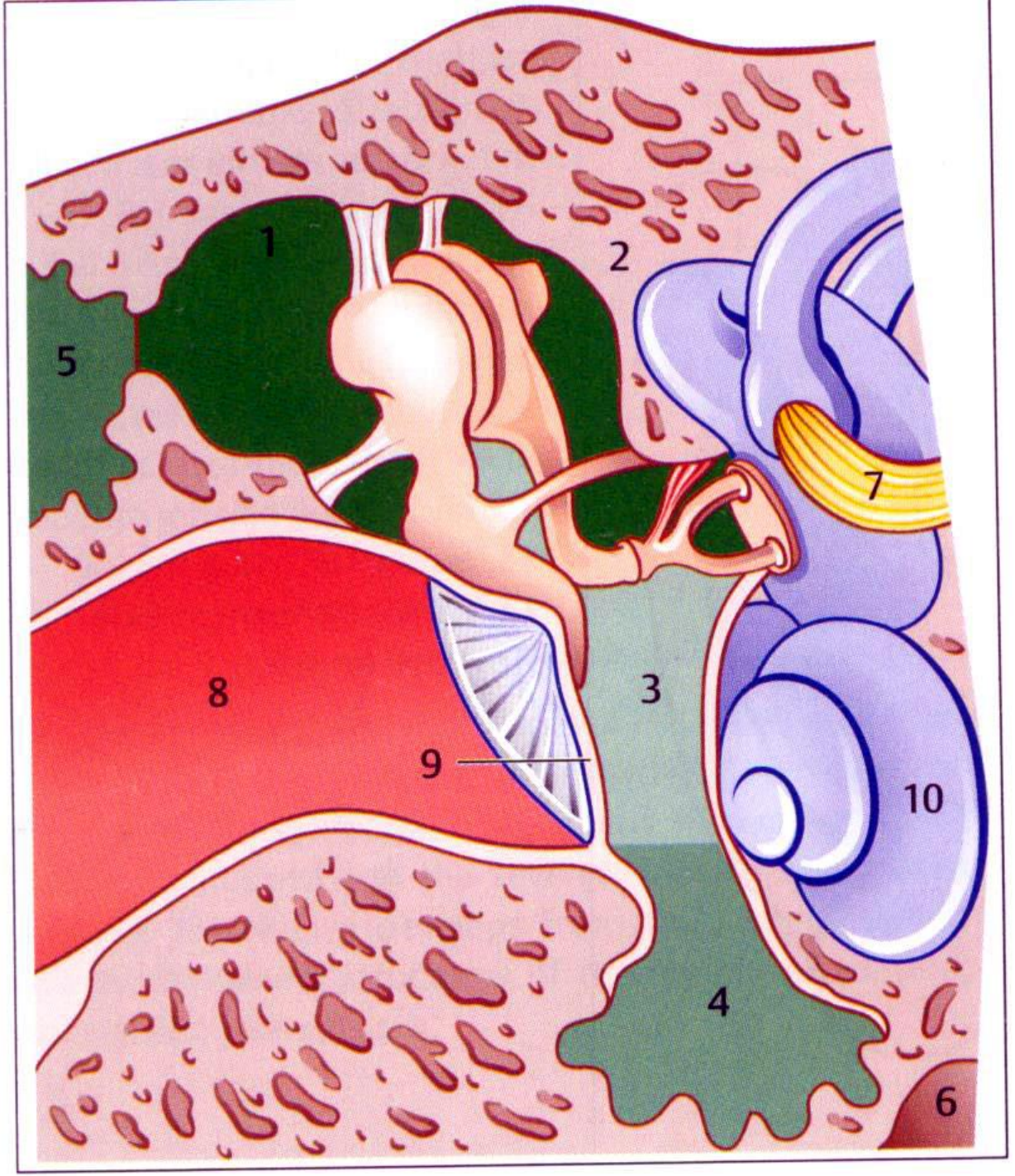
1,2 epitympanic recess
3 mesotympanum
4 hypotympanic recess



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Cavum tympani - (shape of biconcave lens) 6 walls

Paries:

- membranaceus
- labyrinthicus
- tegmentalis
- jugularis
- mastoidea
- caroticus

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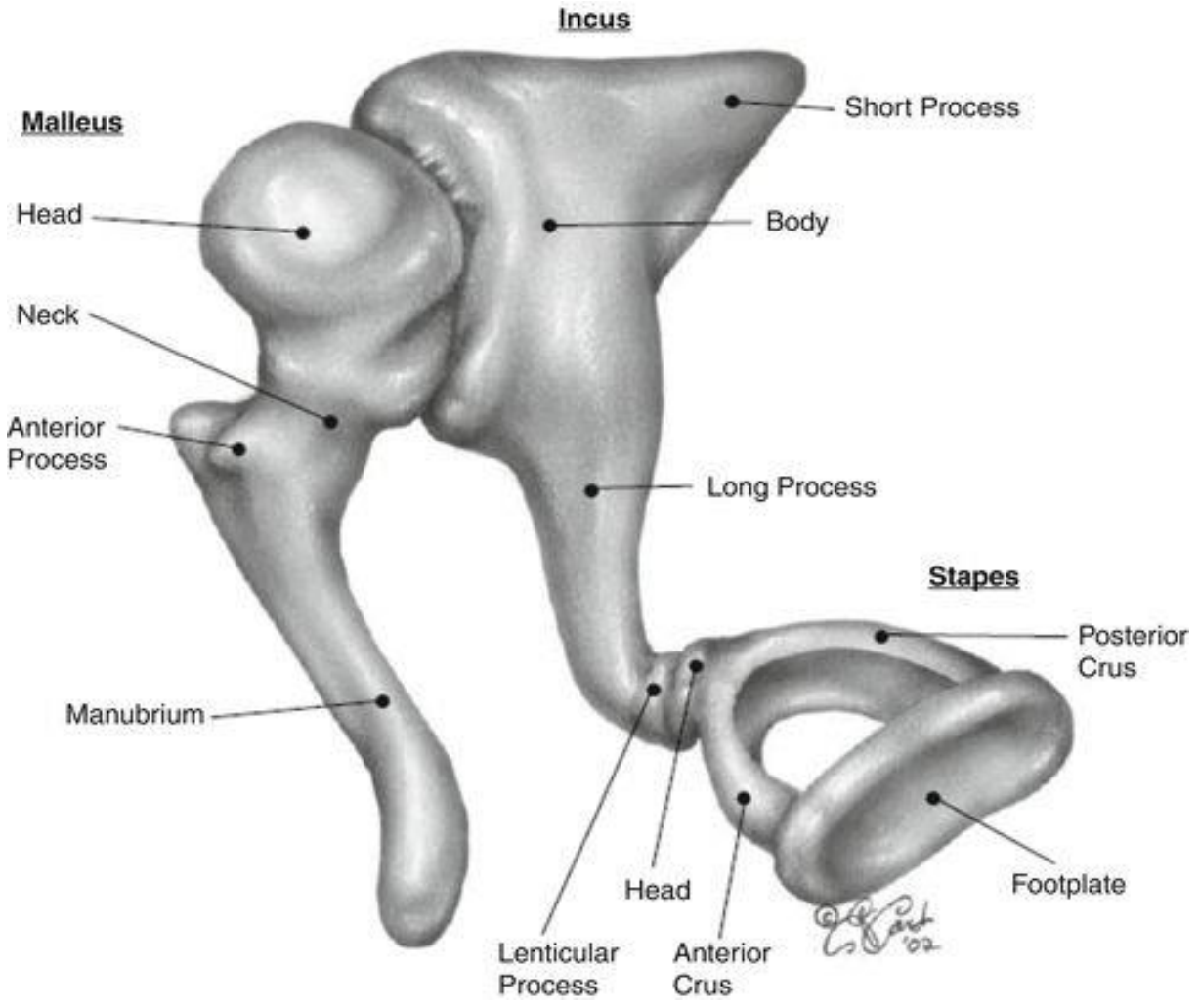
Middle ear

Tympanic cavity (cavum tympani)

ossicular chain:

- *malleus*
- *incus*
- *stapes)*



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HEARING FUNCTION (TRANSFER, SYSTEM)

1. Compensation of loss of acoustic energy (ear- liquid):

   a/tympanic membrane - oval window 14x

   b/ lever-action system of ossicles 1,3x

   c/ lever-action system due to uneven incurvation of ear drum, all together 30-35dB

2. Mutual change of deviation and pressure acoustic vibration .

Gas = great deviation, low pressure.

Liquid = low deviation, great pressure .

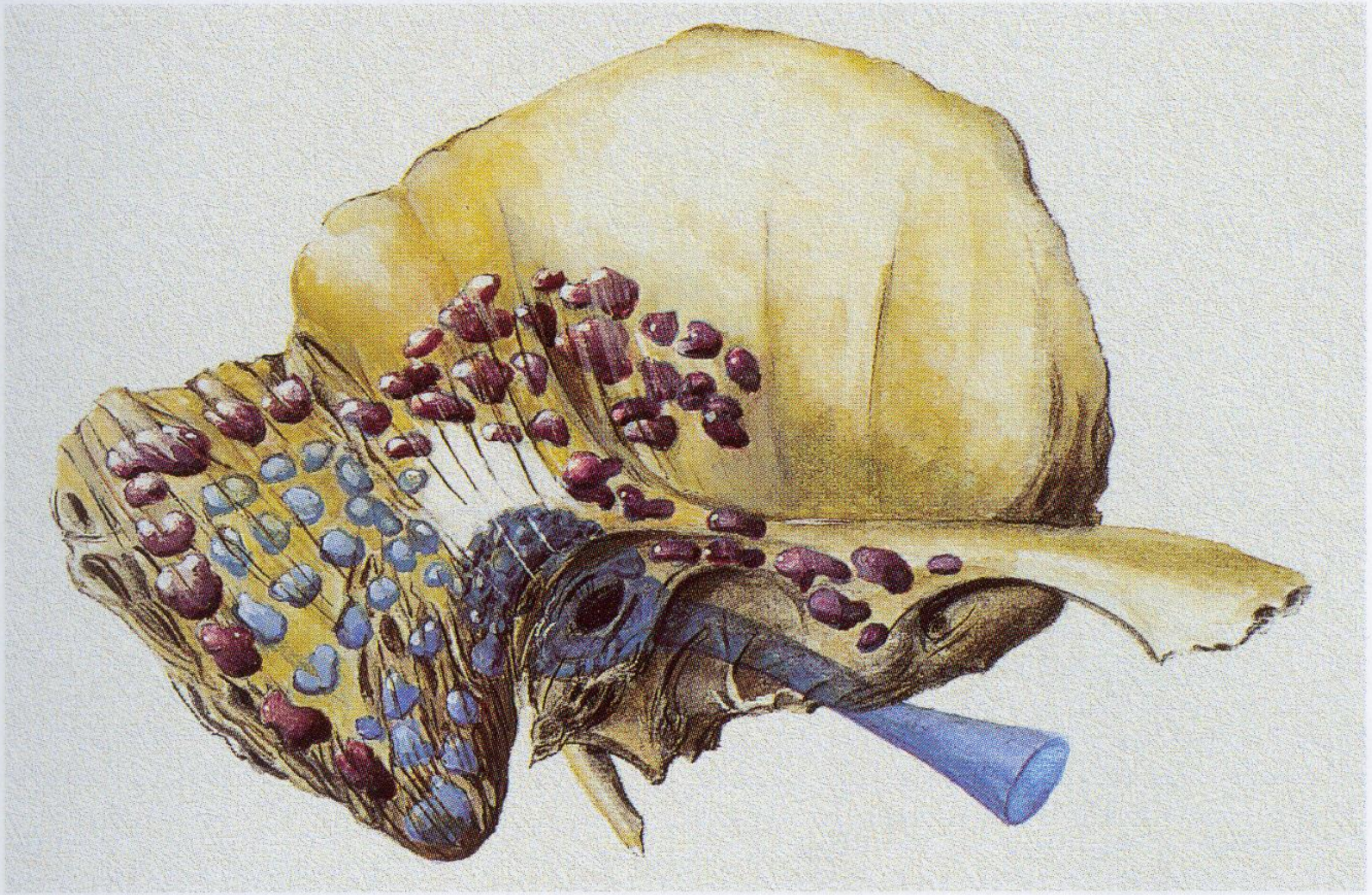

Fig. 26
Pneumatization types of the petrous bone

- compact mastoid process
- restrained pneumatization
- good pneumatization

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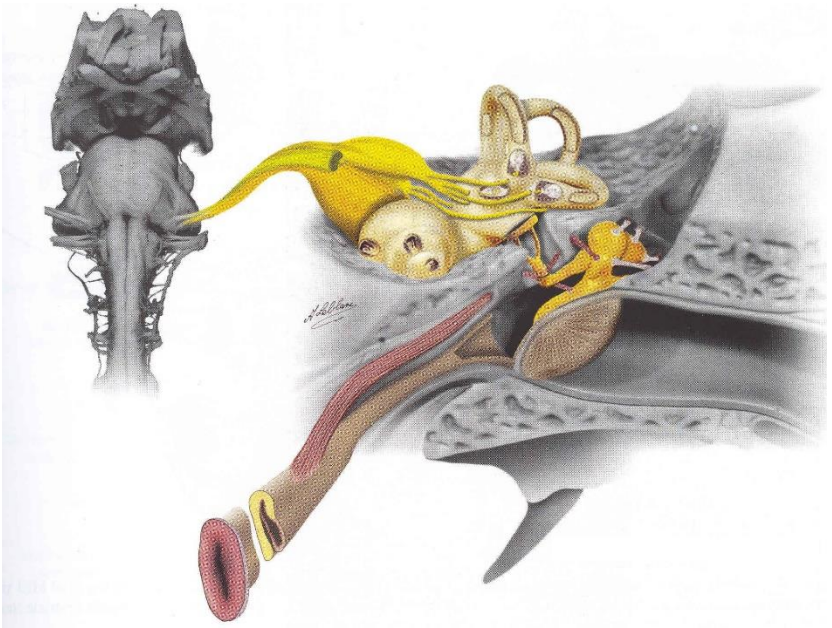
Eustachian tube

- **Ventilation function** - it serves to equalize the pressure between middle ear and the nasopharynx
- **Drainage function** – removal of secretion from middle ear cavity
- **Protective function** - before secretion penetration into middle ear cavity



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SLUCHOVÁ FUNKCE (PERCEPČNÍ ÚSTROJÍ)

Cochlear function:

- Change of mechanic vibration on neural excitation
- Basic frequency analysis

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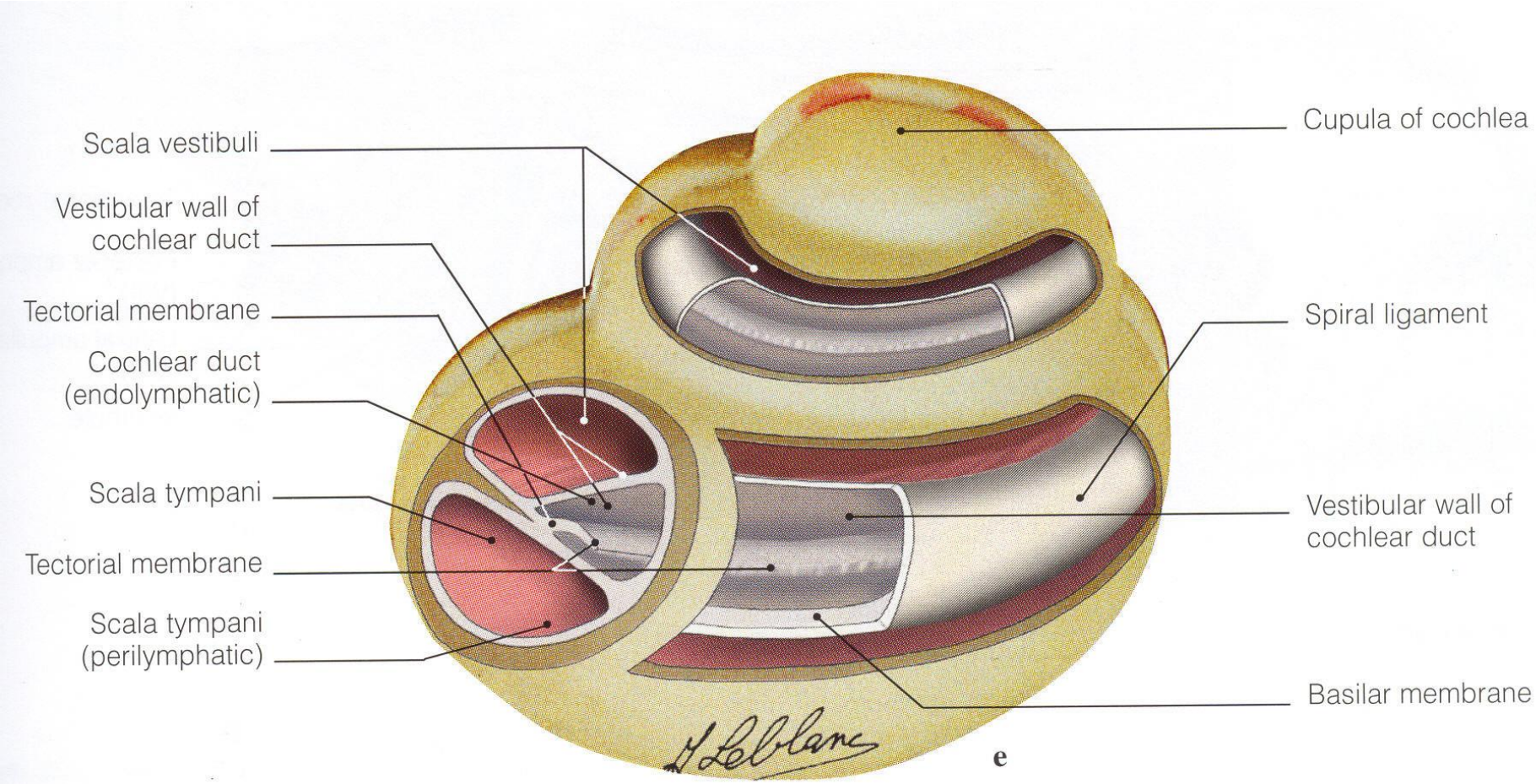
Cochlear cross-section



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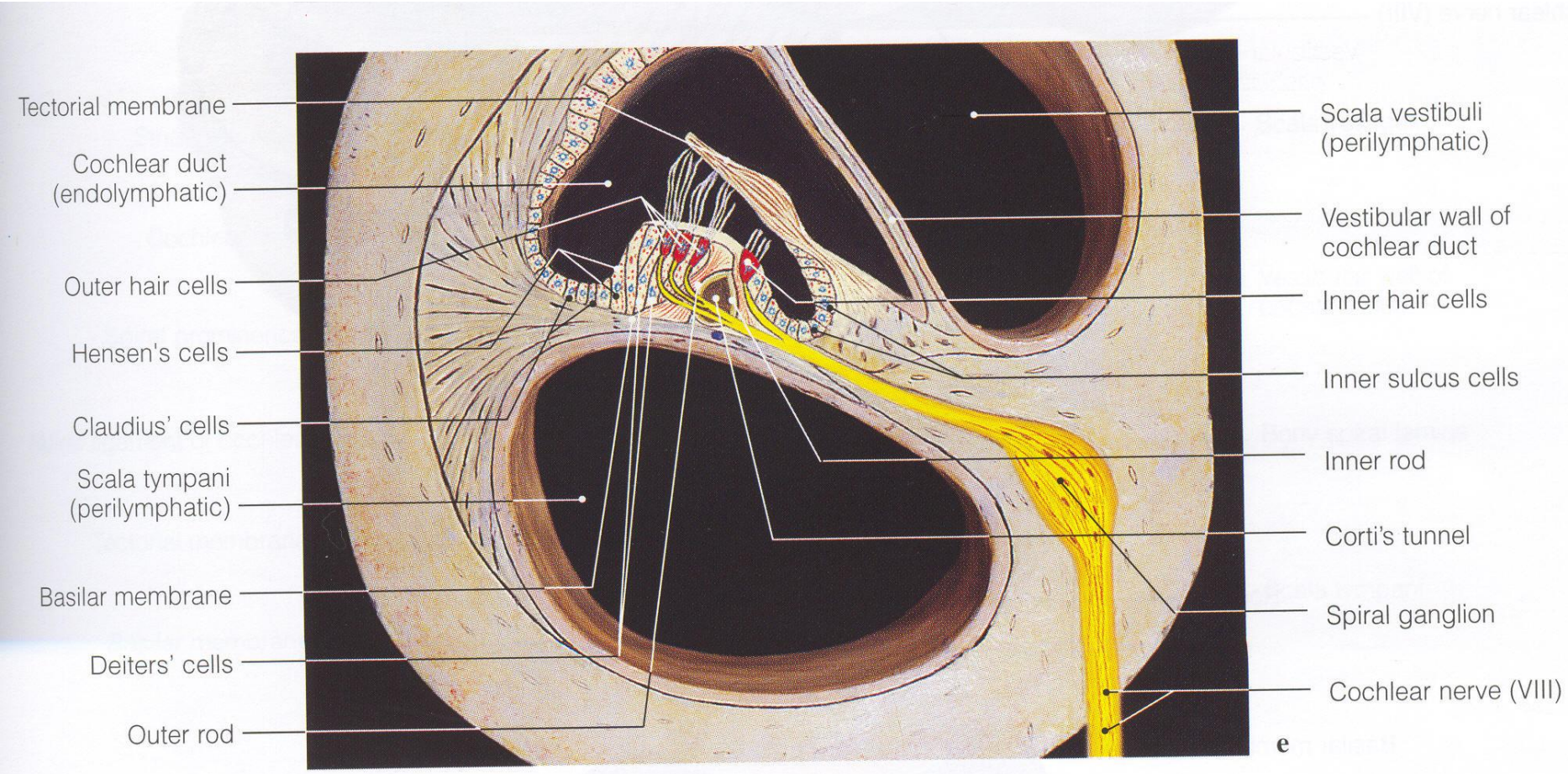
Cochlear duct cross-section



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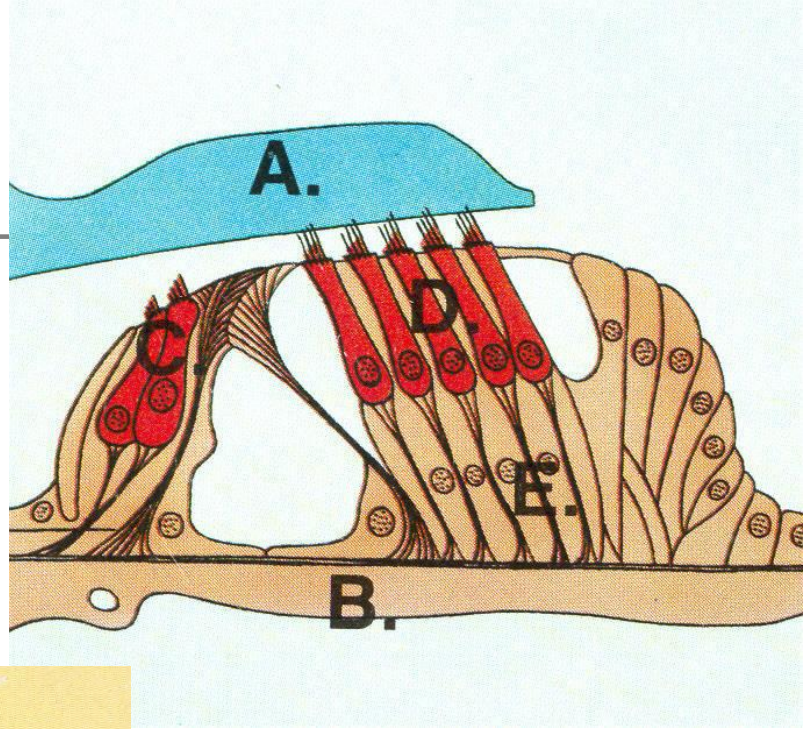
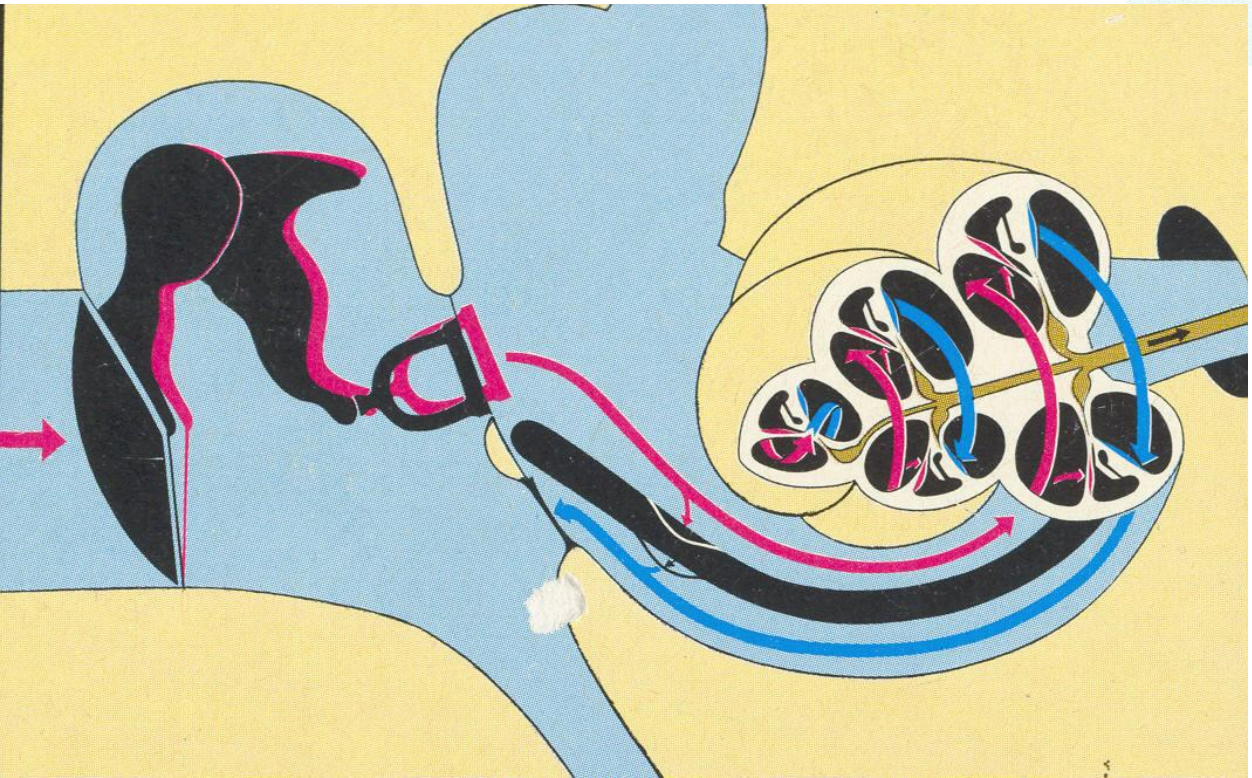
Conduction of vibration from tymp. membr. through cochlea, Organon Corti





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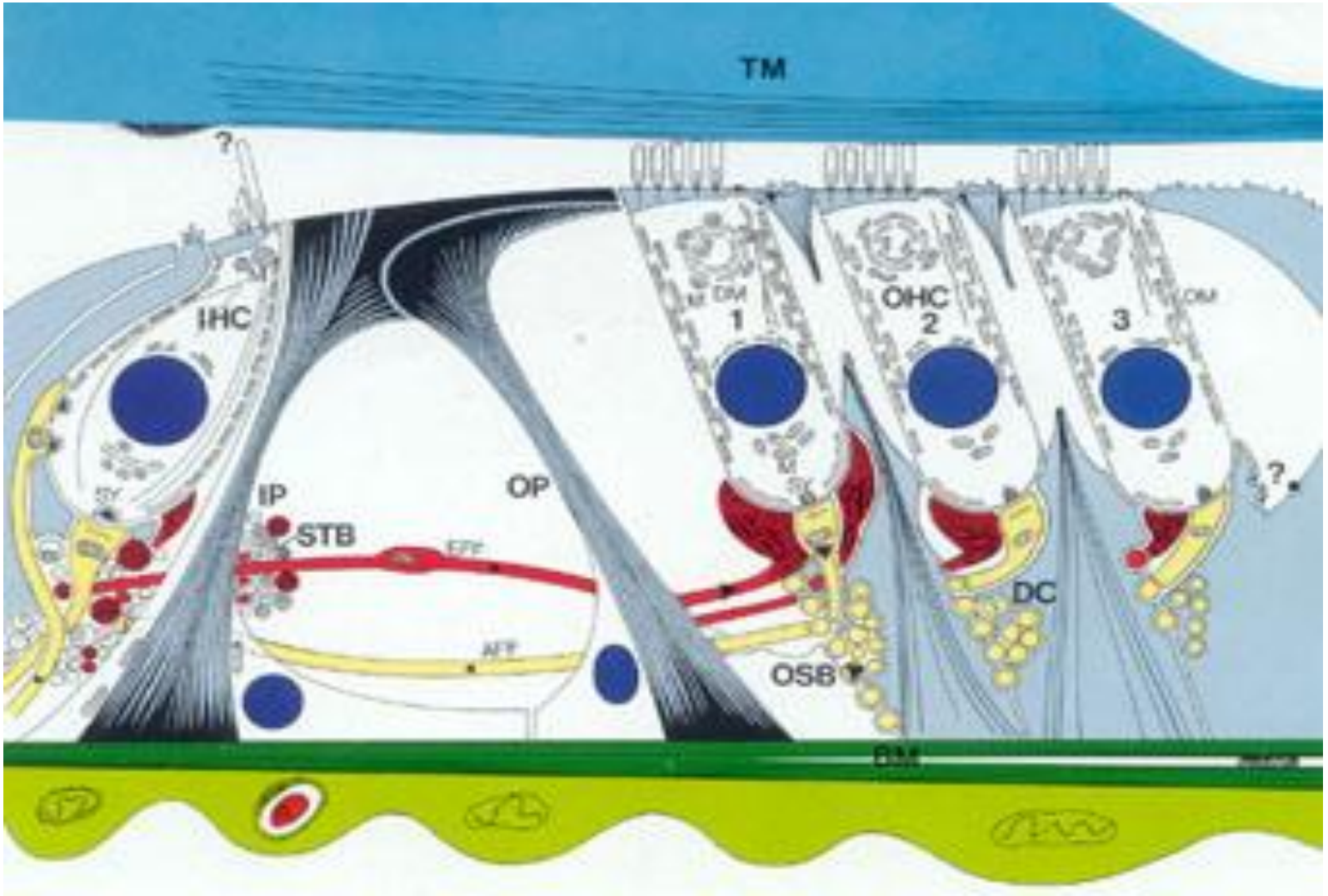
Outer hair cells (OHC) = servomechanism for inner hair cells (IHC)



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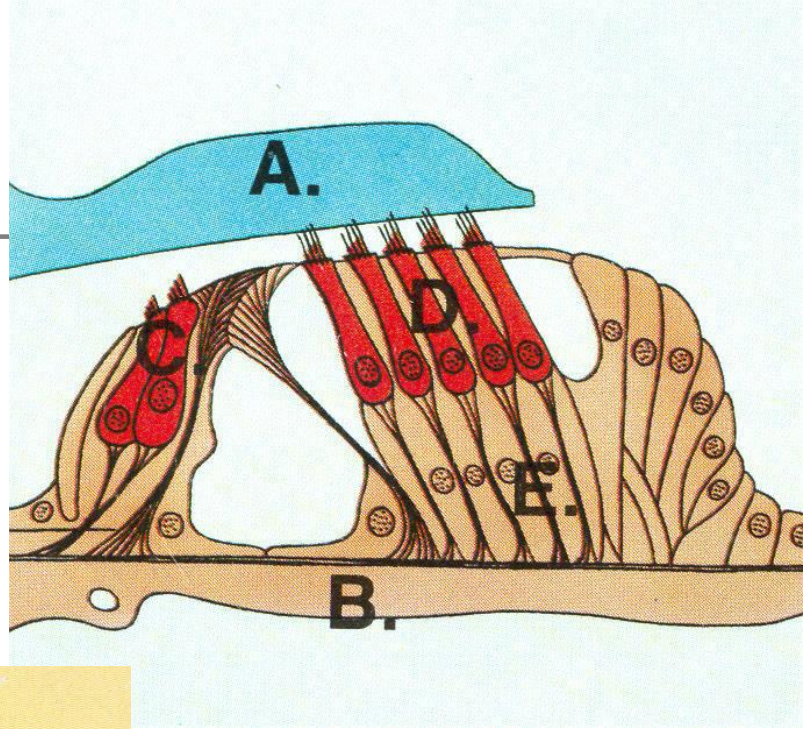
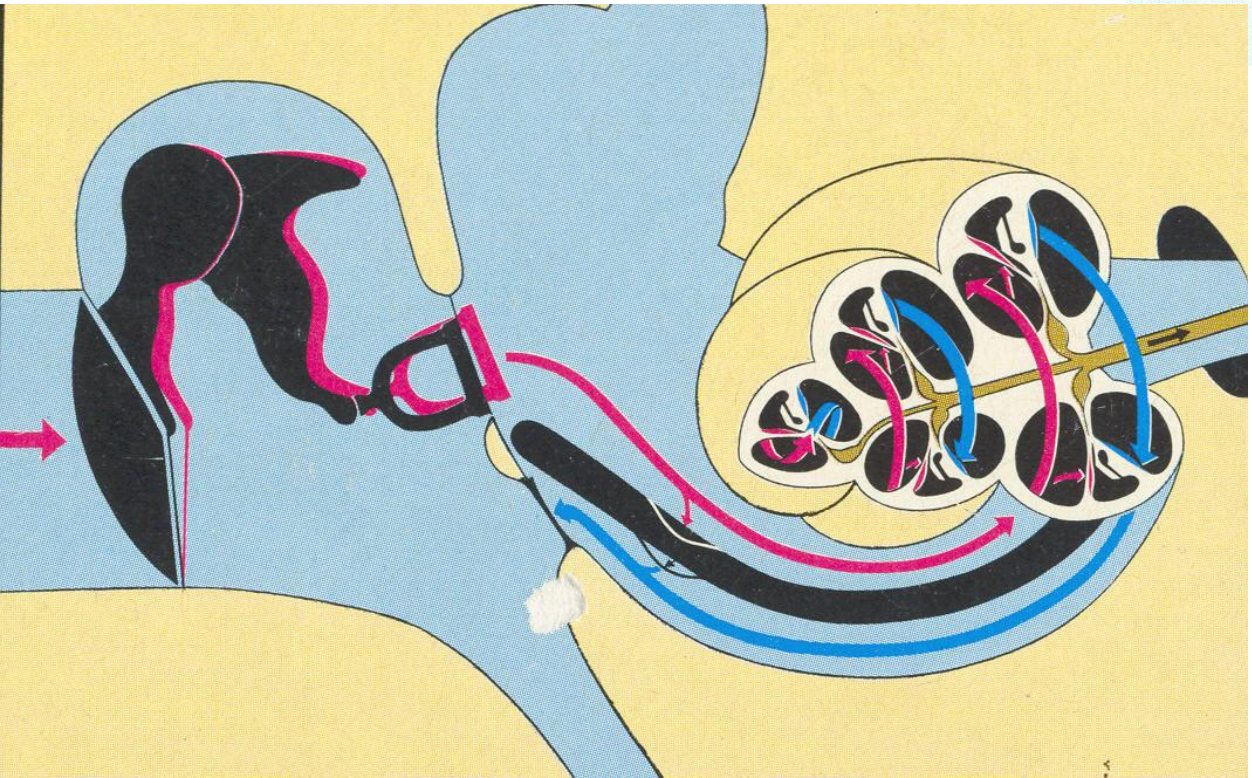
routing vibration from ear drum through cochlea, Organon Corti





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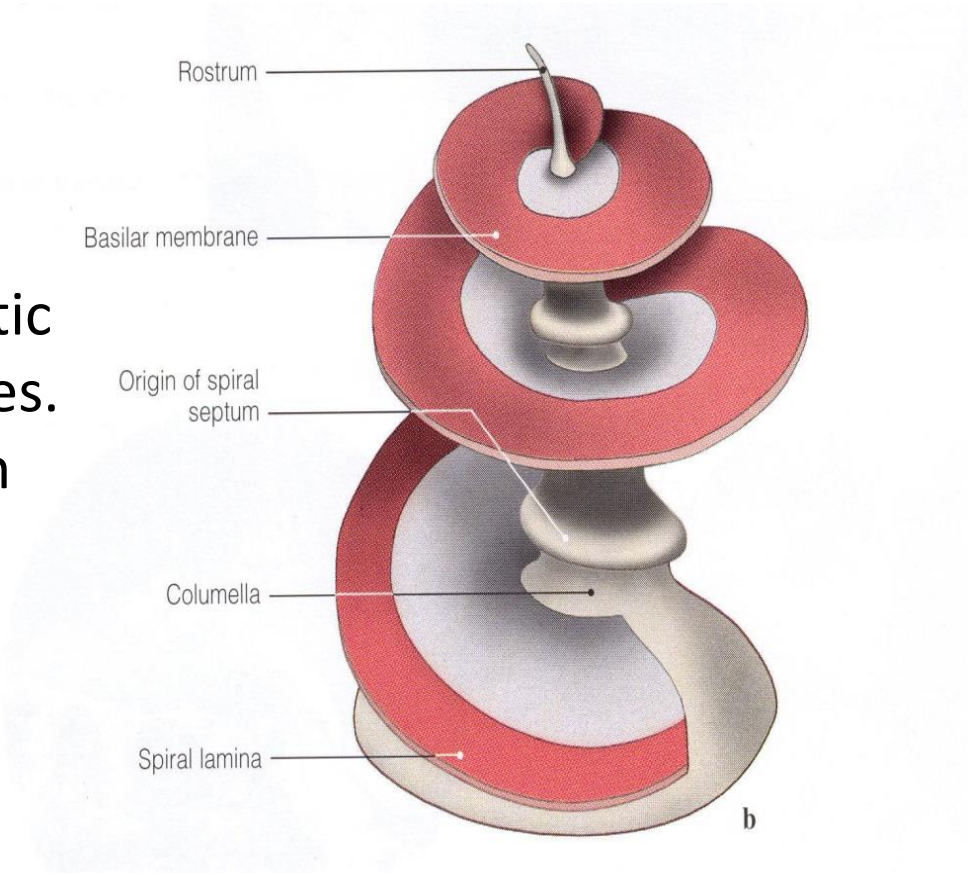
Cochlear septum

System of 3 membranes – membrana basilaris, reticularis, tectoria

Principle of tonotopy

– as higher frequency, the acustic pressure balanced near to stapes. High frequency are perceived in basal whorl, low frequencies in apical whorl.



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Wave hydrodynamic theory of hearing
(von Bekesy theory of „traveling wave“)

- Acoustic tension is led from ear drum through ossicles into oval window.
- Liquid is je not compressible, pressure changes are equalized on round window membrane, which vibrate in anti phase to stapes.
- Acoustic pressure is equalized on cochlear septum and it create wave.
- a sound impulse sends a wave sweeping along the basilar membrane. ... And as Helmholtz had postulated, **Bekesy** found that the high-frequency tones were perceived near the base of the cochlea and the lower frequencies toward the apex." (principle of tonotopy).
- „ traveling wave“ leads to shift of tectorial membrane of Organon Corti in relation to basilar membrane and deflection of hairs of sensory cells
- Thus the mechanic energy is changed into electric potential in VIII cranial nerve.

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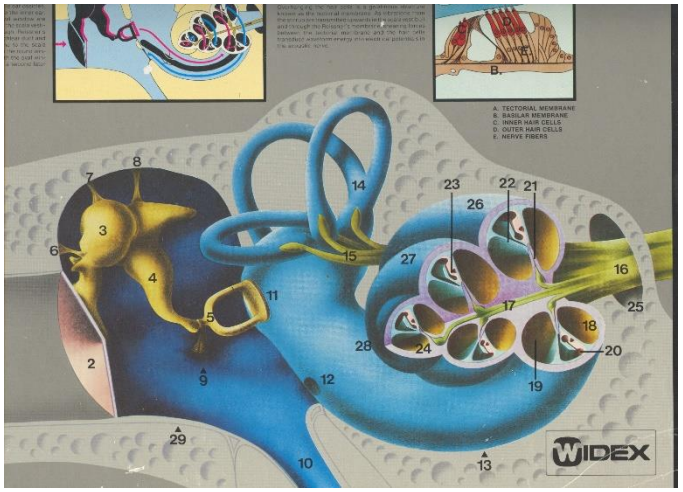
Vestibular system

Basic function

- Equilibrium of human body in stand and in walking
- Stabilization of retinal picture and keeping visual sharpness in movement



Basic reflex circles

- vestibulo-ocular reflex (VOR)
- Vestibulo-spinal reflex (VSR) - help keep head and body in upright position due to vestibulospinal system.

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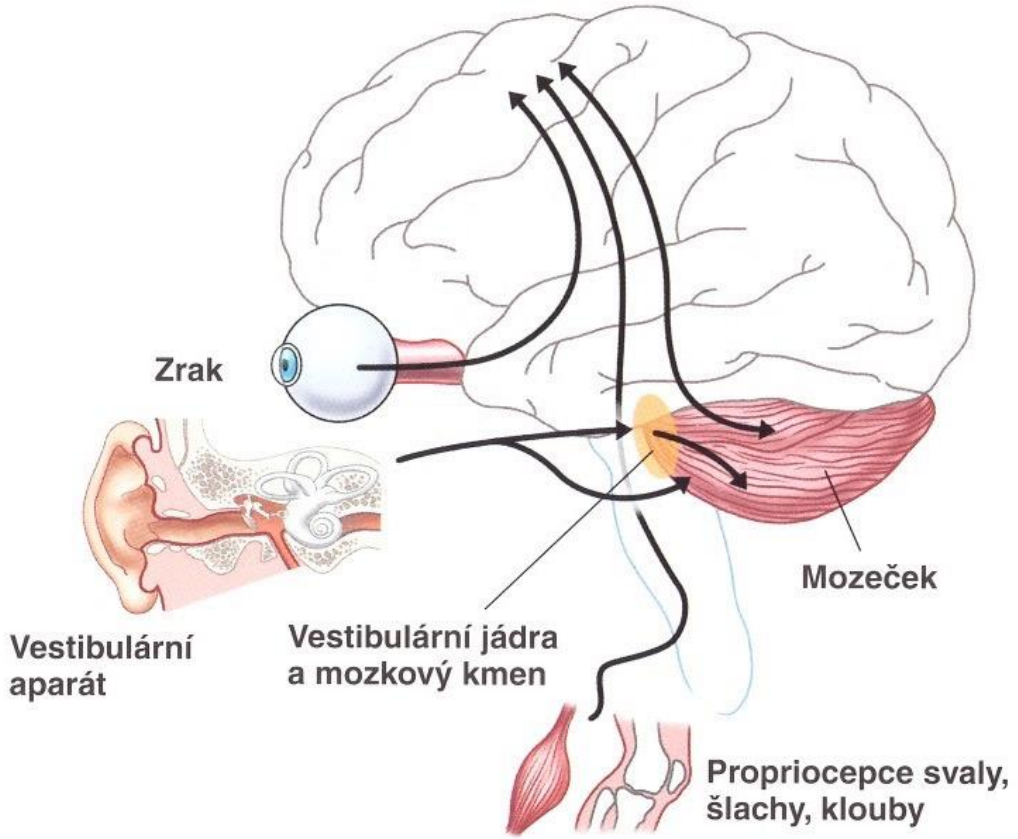
Equilibrium

Interaction of eye, vestibular-semicircular system, proprioception and cerebellum on keeping balance

Three afferent sources of equilibrium: eye, proprioception and vestibular system.



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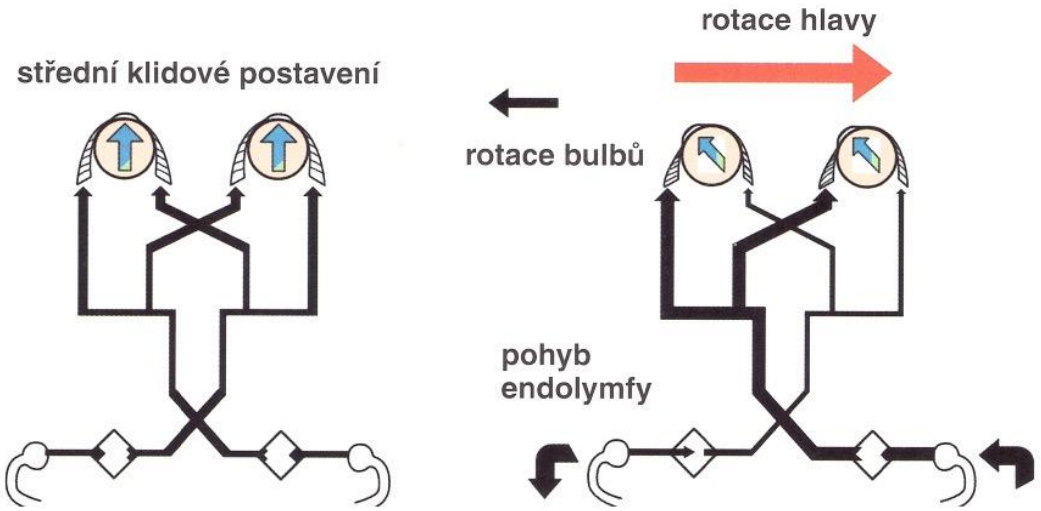
Vestibulo-occular reflex

Create movement of eye, which are opposite to movement of head in some plains. Nystagmus – conjugated, coordinated eye movement around a specific axis. **The movement consists of rhythmically alternating slow – and fast beating phases.** The direction of the fast components determines the laterality of the nystagmus.



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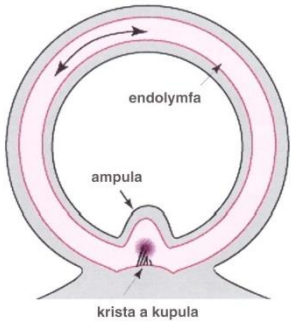
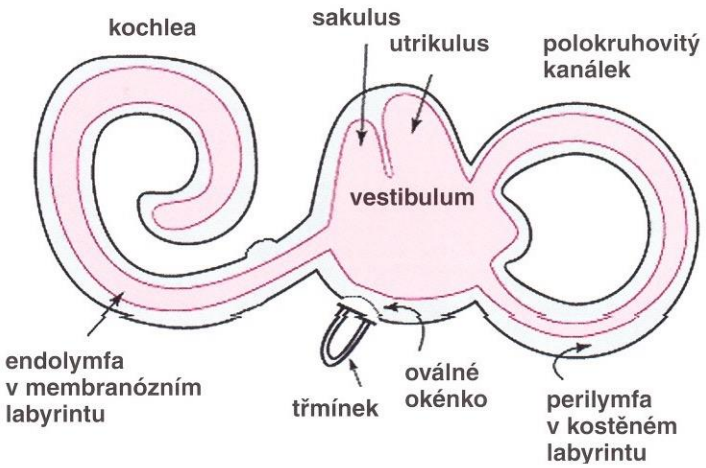
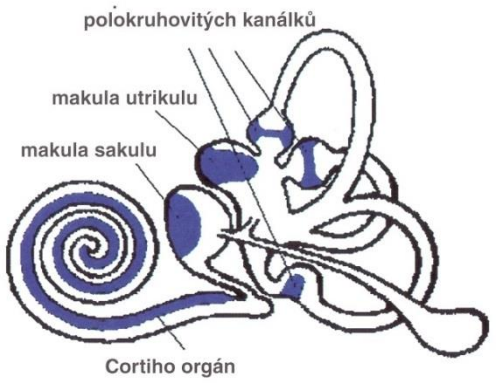
Membranous labyrinth

- Vestibular apparatus localized in pyramis ossis temporalis; membranous labyrinth: saccule, utricle and three semicircular canal; filled with endolymph.
- Every semicircular canal begins with pars **ampullaris with ampullary crest**, sense organ is **static macula**.







Section of semicircular canal, schema of membranous labyrinth (with one canal), sensory organs.

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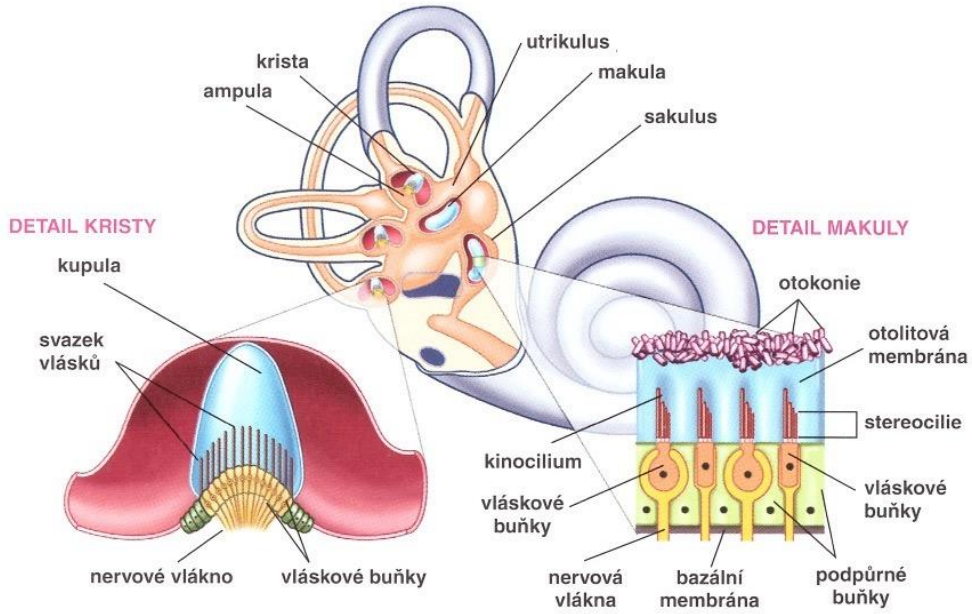
Genesis of receptor potential

Ampullary crests and **maculae utricle and saccule** are created **supporting cells and hair cells**. On their surface lie the **otoliths** (statoconia) – calcium carbonate crystal.

Linear acceleration changes the otolith pressure, **deflecting the sensory hairs.** this stimulates the sensory cell by altering the resting **potential**.



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Vestibular function Tests

- History – subjective feeling of dizziness
- Nystagmus
- Vestibule-spinal and cerebellar reflexes:
  - Hautant test (spontaneous deviation test),
  - Romberg test,
  - Barany test (finger-nose pointing test) ; posturography
- Head impulse test: from mild eccentric head position we provide passive quick rotation movement from side to side.

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Vestibular function Tests

- Head shaking nystagmus – spontaneous Ny can be provoked by gentle, passive, horizontal shaking of the patients head
- Detail evaluation of eye movement - electronystagmography, video oculography
- Unterberger test, walk „on the rope“
- Stabilometric plain - static and dynamic

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Vertigo (dizziness)

- ***Periferal type*** **– feeling of rotation of itself body or surroundings, direction of rotation is usually into healthy part, loss of stability or feeling of swimming**
- ***Central type*** **– ineptitude by walk, inability of walk, vertigines with aura (EPI), disorder of vision *"black outs"* – diplopia is seen by disorder of oculomotory.**

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Differential diagnosis peripheral vs. central vestibular syndrome

Symptom	Peripheral (harmonic) VS	Central VS
Nystagmus	Horizontal rotatory on side of most reactive labyrinth	Other then Horizonttal rotatoric (olnz horiyontal, vertical, „gaze“ nystagmus, rebound nystagmus etc)
Tonic deviation	On side of weak labyrinth (to affected ear) in relation to position of head	Without to relation to head position
Eye fixation	In abscence of eye fixation nystagmus is growing	In abscence of eye fixation nystagmus not changejd
Cranial nerves	Without laesion (excl.: n. VII)	Laesion of cranial nerves present
Cerebellar symptoms	Not present	Could be present
Disturbance of occulomotoric function	Not present	Could be present
Hearing disorder	Usually Could be present	Usually Not present
Central compensation	Gradually compensation, harmonic symptoms: intensity of vertigo correlates with nystagmus intensity and tonic deviations	Not present, disharmonic symptoms

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History of ear disease

Physician itself is a „remedy“. (Michael Balint)

Hearing disorder

Otorhoea

Ear discharge

Tinnitus

Pain

Dizzines

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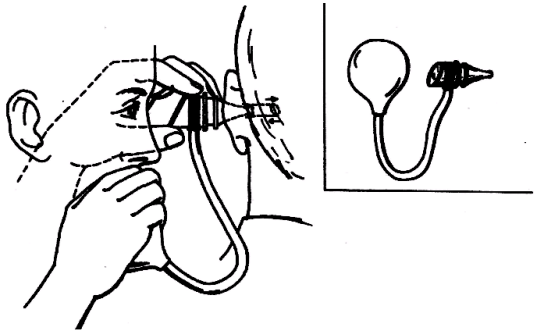
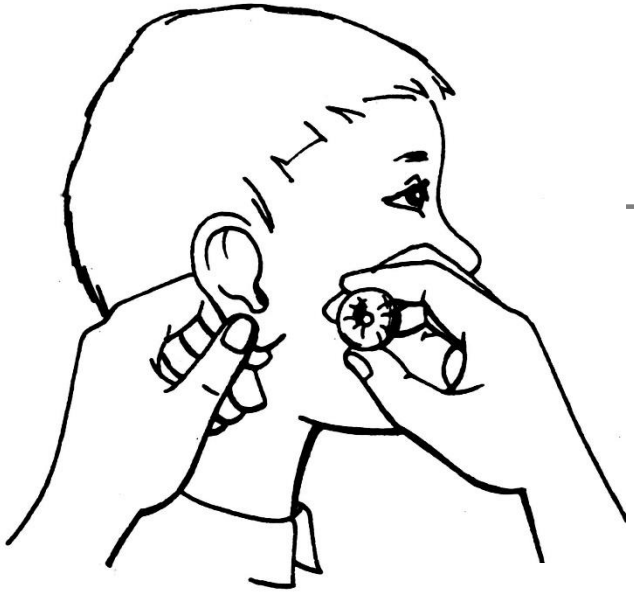
Ear evaluation, oto(mikro)scopy

- **Aspection and palpation**
  - Auricle shape, deformities
  - Skin lesions, scars (also retroauriculars)
  - Discharge from external meatus
  - Pain in pressure on tragus (by otitis externa)
  - Pain in pressure on processus mastoideus (by mastoiditis acuta)

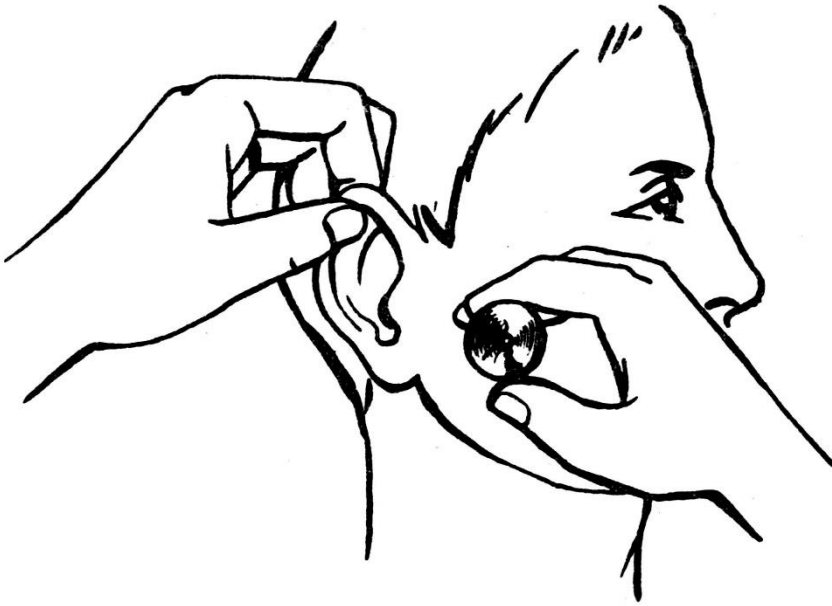
- **Otoskopy and oto(mikro)scopy evaluation**
  - Ear speculum
  - Illuminated otoscope, pneumo-otoscopy
  - otomicroscope



Vyšetřování Sieglovým zrcátkem



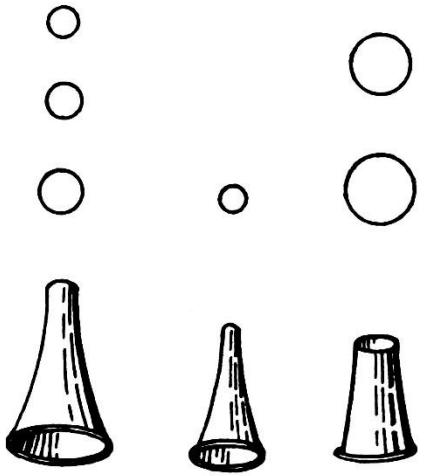
Obr. 13: Zavádění ušního zrcátka u dítěte



Obr. 12: Zavádění ušního zrcátka u dospělého

Otoscopy

eye evaluation of deeper parts of external meatus and ear drum



Obr. 11: Ušní zrcátka

The cartilaginous part of ext. meatus is stretched by pulling the auricle upward and backward

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Bezold´s trias

- Prominentia mallearis
- Stria mallearis
- Light reflex

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Otoscopy – tympanic membrane quadrants and zones

p – prominentia malleoli
l – stria malleolaris
u – umbo
r – světelný reflex

Kvadranty:
pd – přední dolní
pp – " horní
zd – zadní dolní
zh – " horní

zóny: c – centrální, l – intermediální, p – periferní

Rozdělení bubínku na kvadranty a zóny

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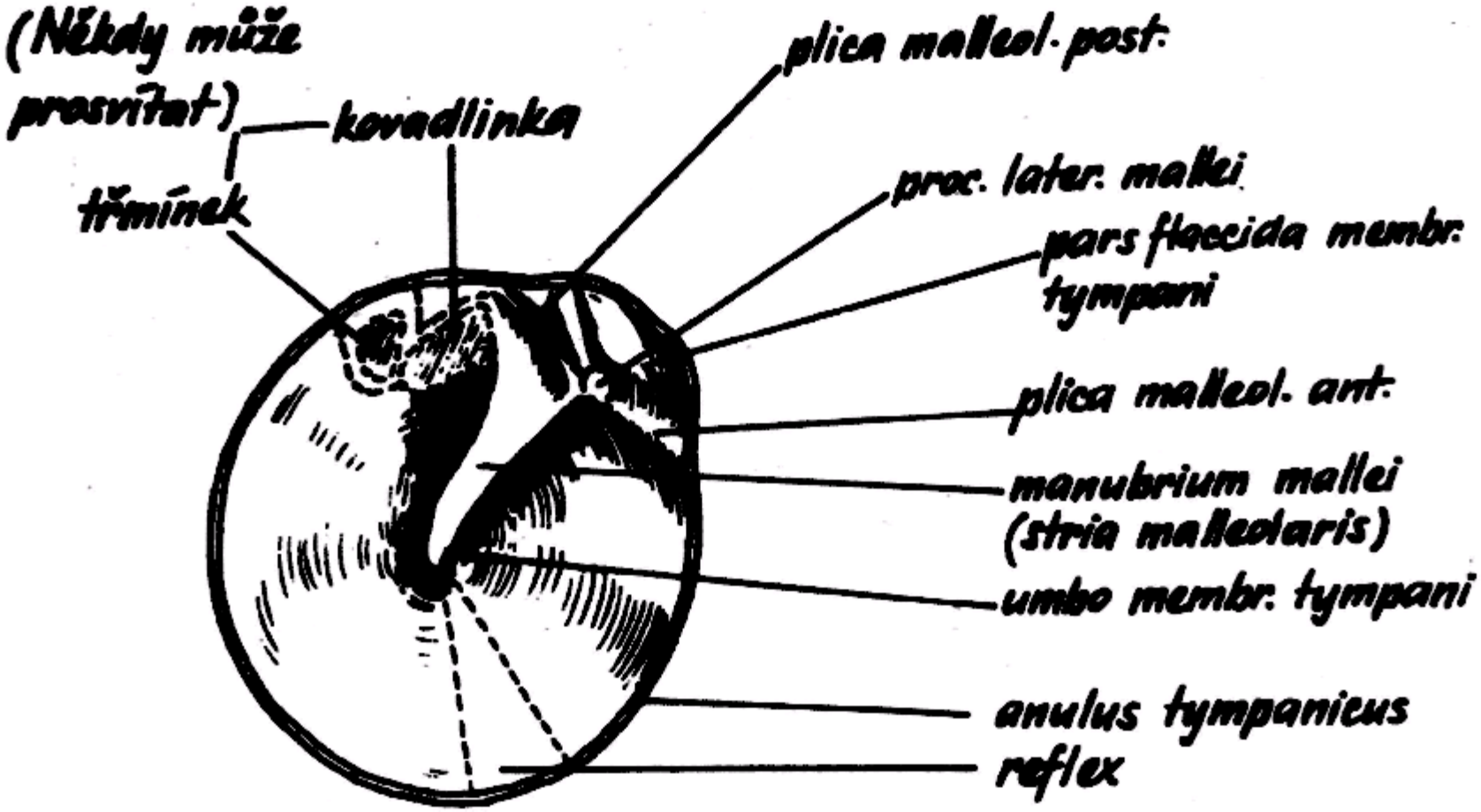
Normal ear drum



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Basic pathologic finding on tympanic membrane

- Injection of the vessels of the tympanic membrane
- **(position) bulgging due to exudate** - hyperemia, moist infiltration and opacity of the surfice, the contours of the handle of mellaeus and short process disappear
- **retraction** - injection of blood vessels
- **(integrity) perforations –**
  - **after injury**
  - **inflammatory - acute**
- **- chronic** - central (mesotympanic)
- - marginal (peripheral)
- **(changes after infamm.) thickening of the tympanic membrane, scars**
- changes **behind** the ear-drum: middle ear efussion, fluid level, air bubbles

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Various types of ear drum perforations

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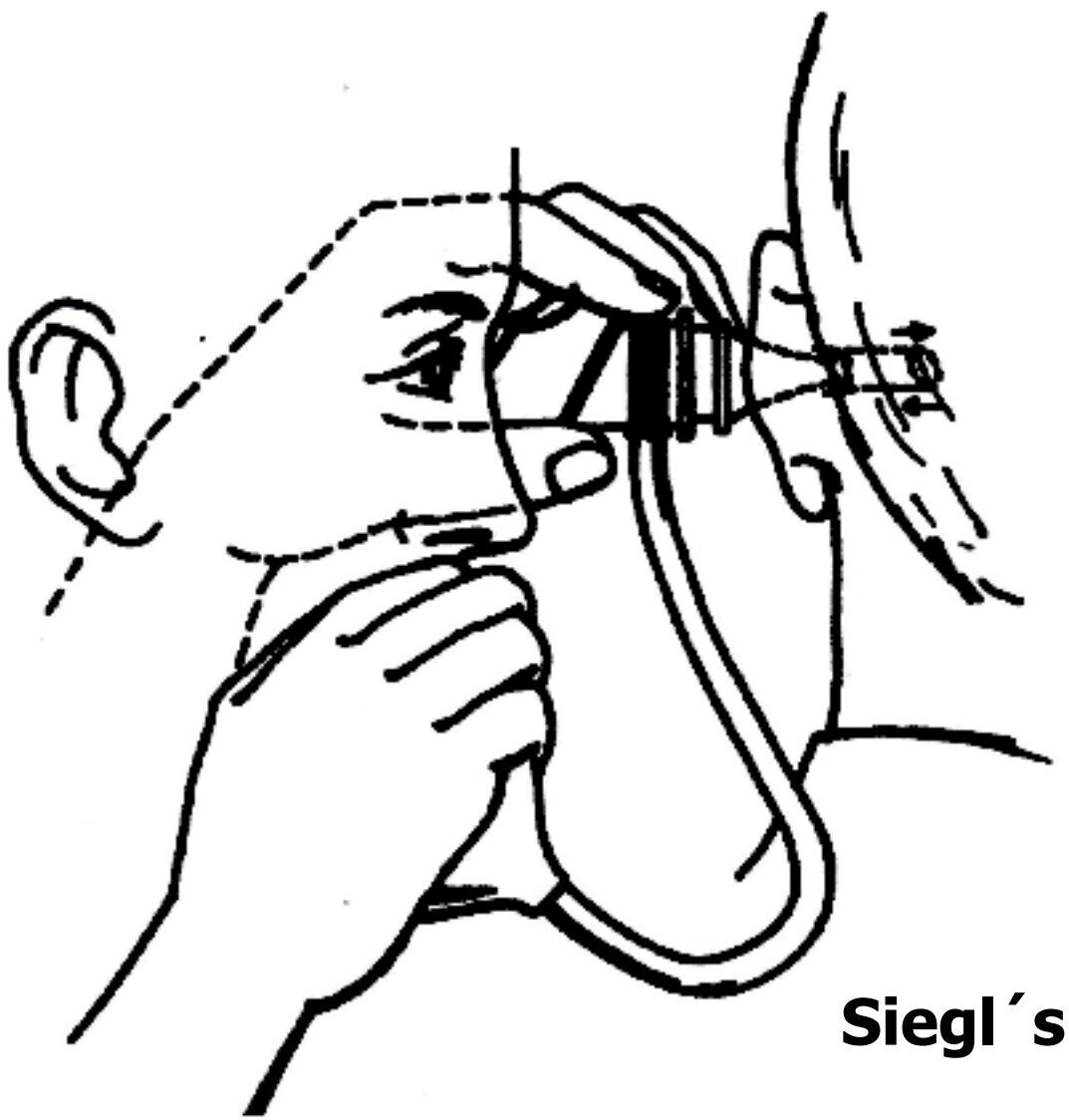
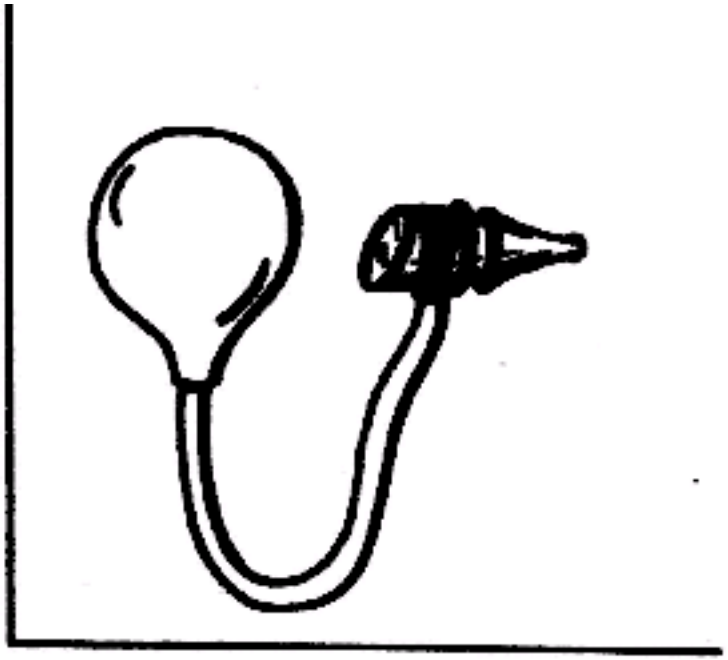
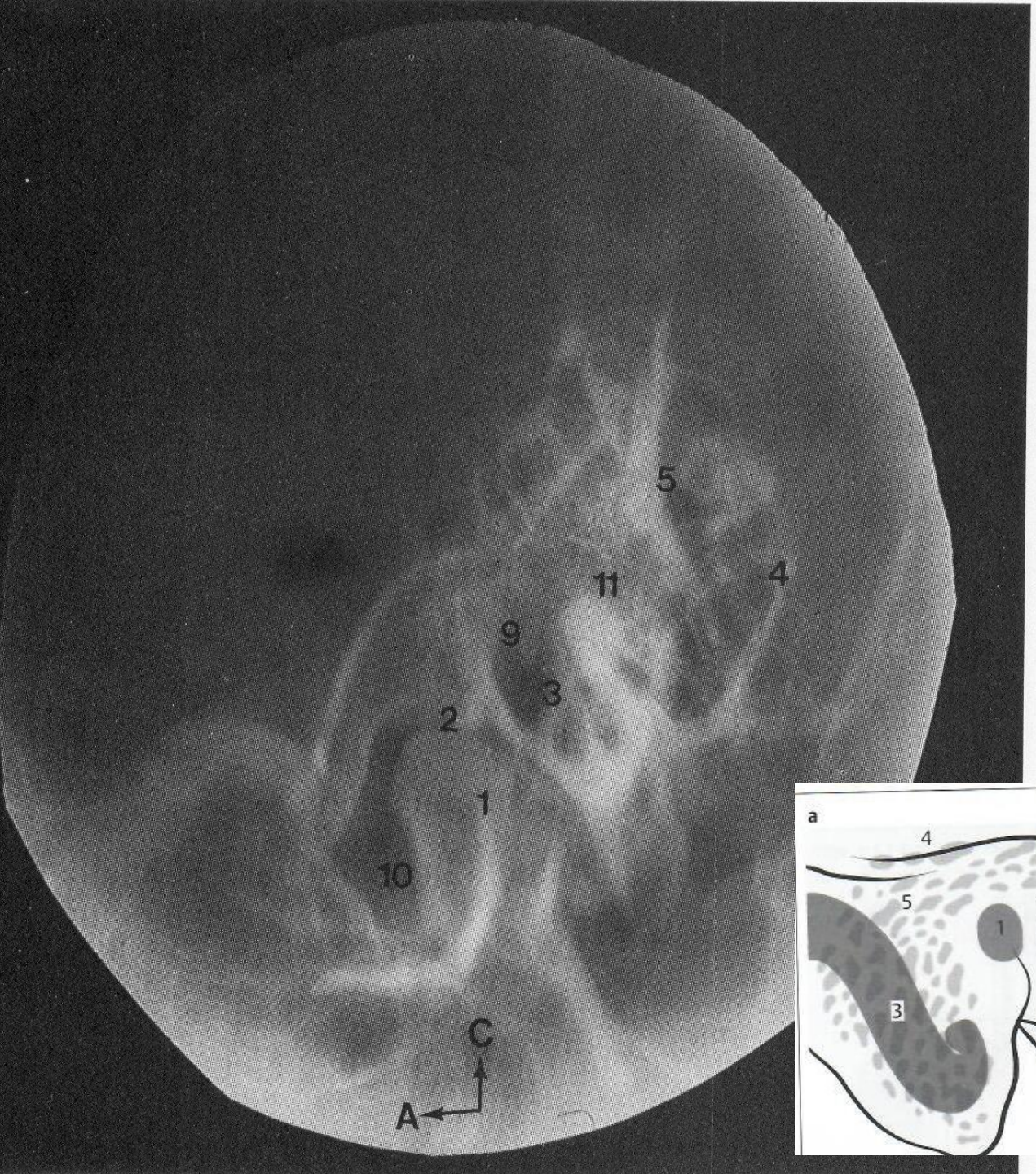
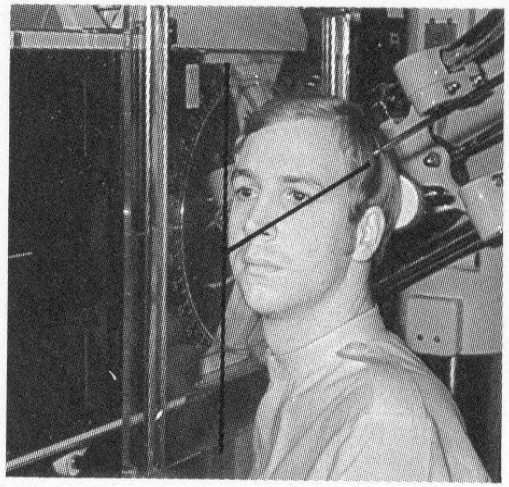
Siegl´s ear speculum



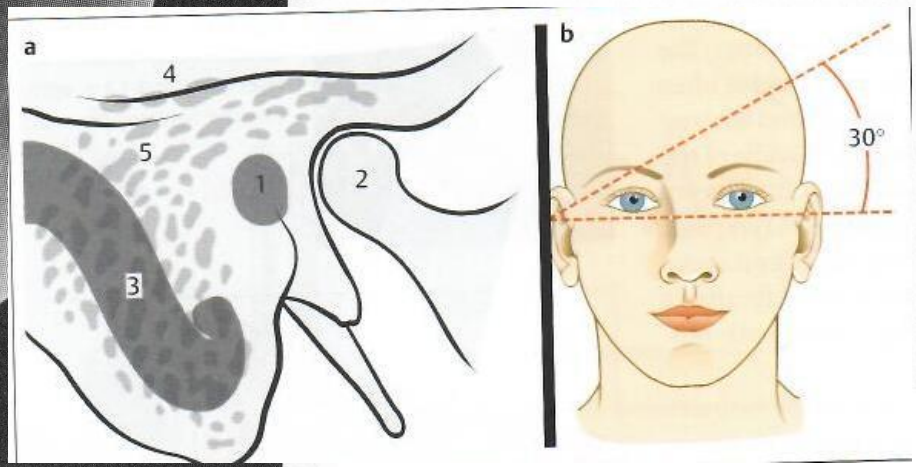


Siegl´s ear speculum



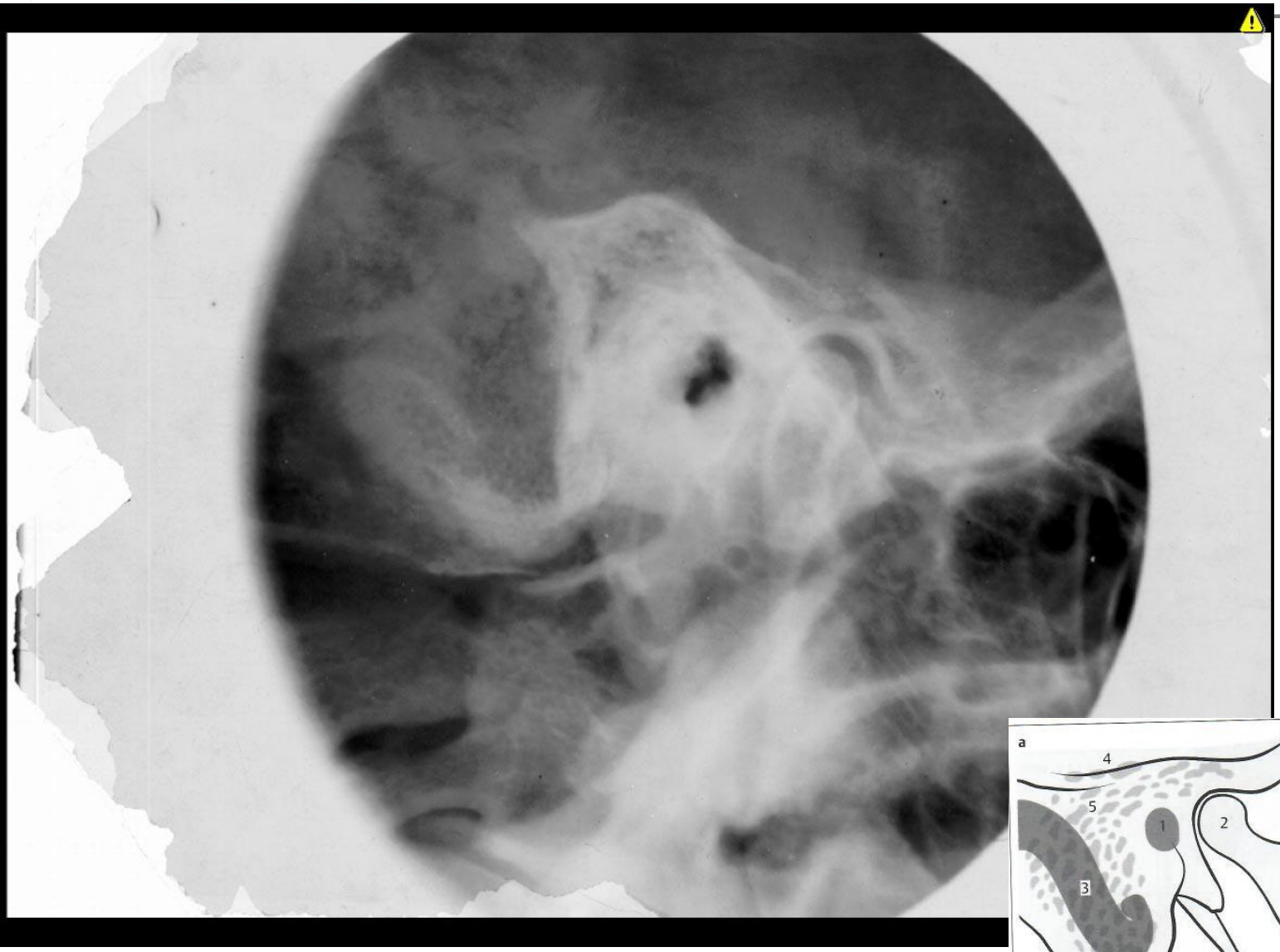


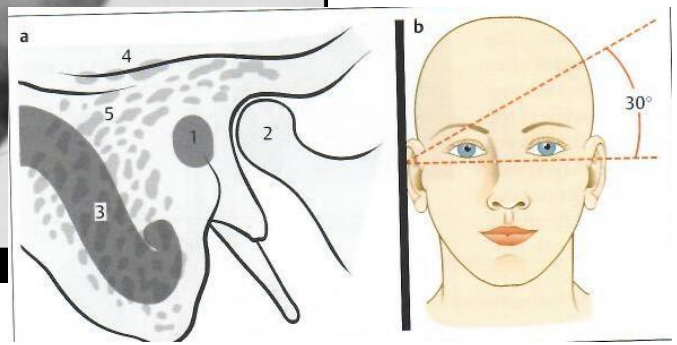
Radiographs in Schüller wiev



FAKULTNÍ NEMOCNICE U SV. ANNY V BRNĚ

Radiographs in Schüller wiev

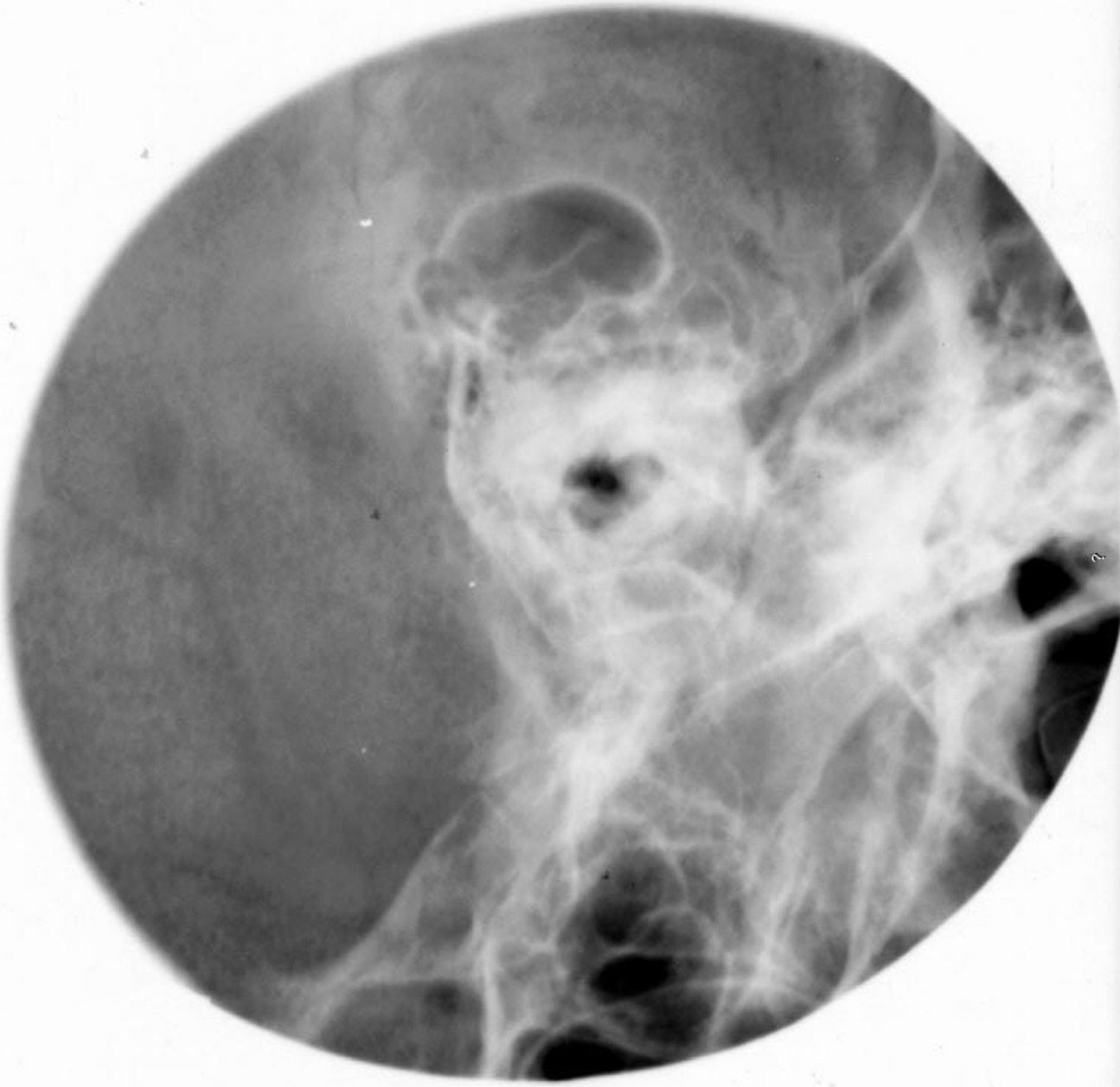




Mládková

Otitis med. sup. ac. c. mastoiditide
(Velké zastření pneumatického systému)

Normální výběžek.



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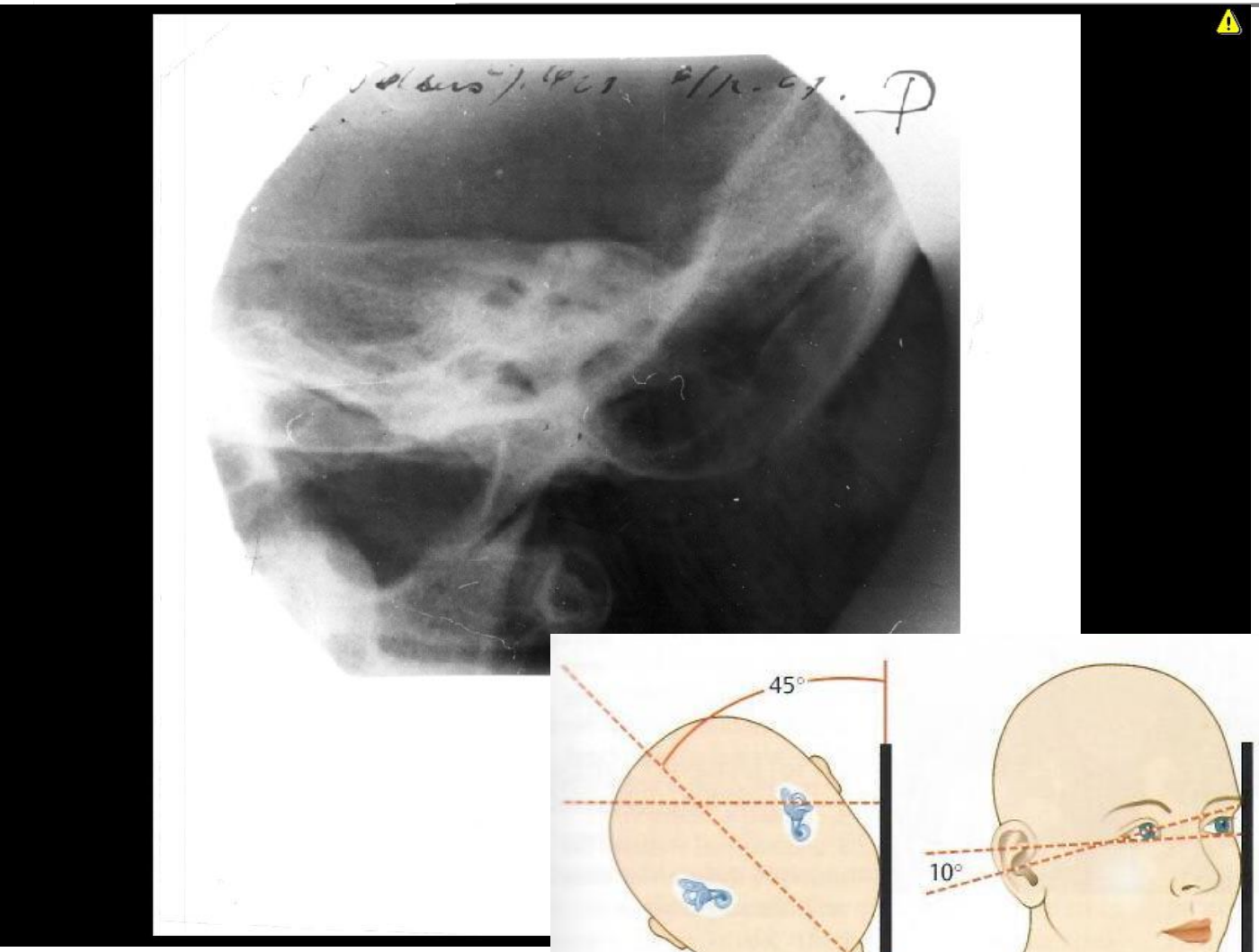
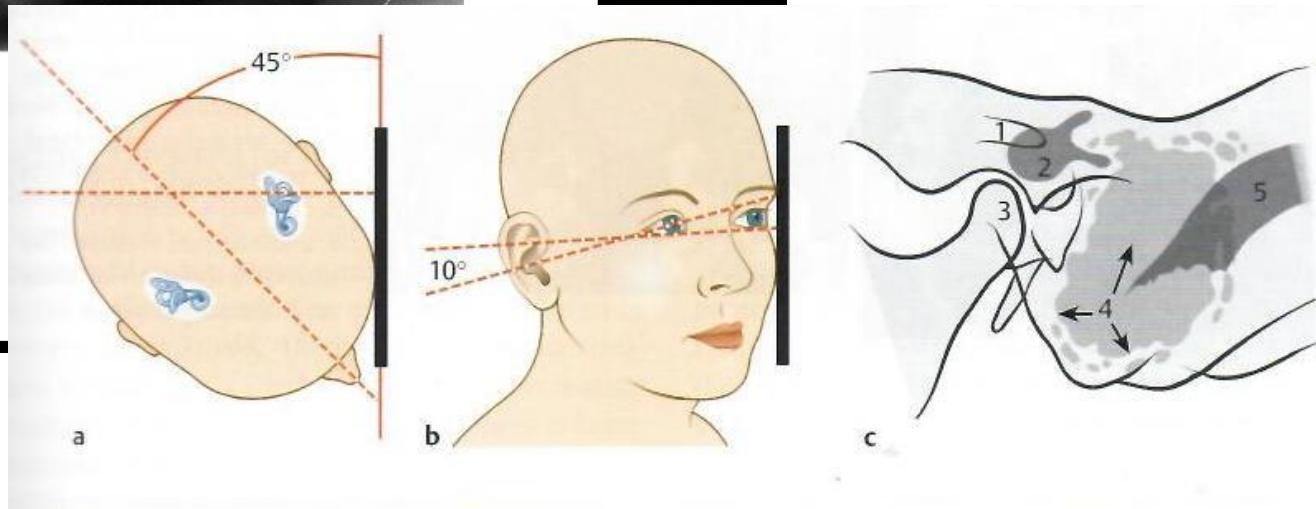
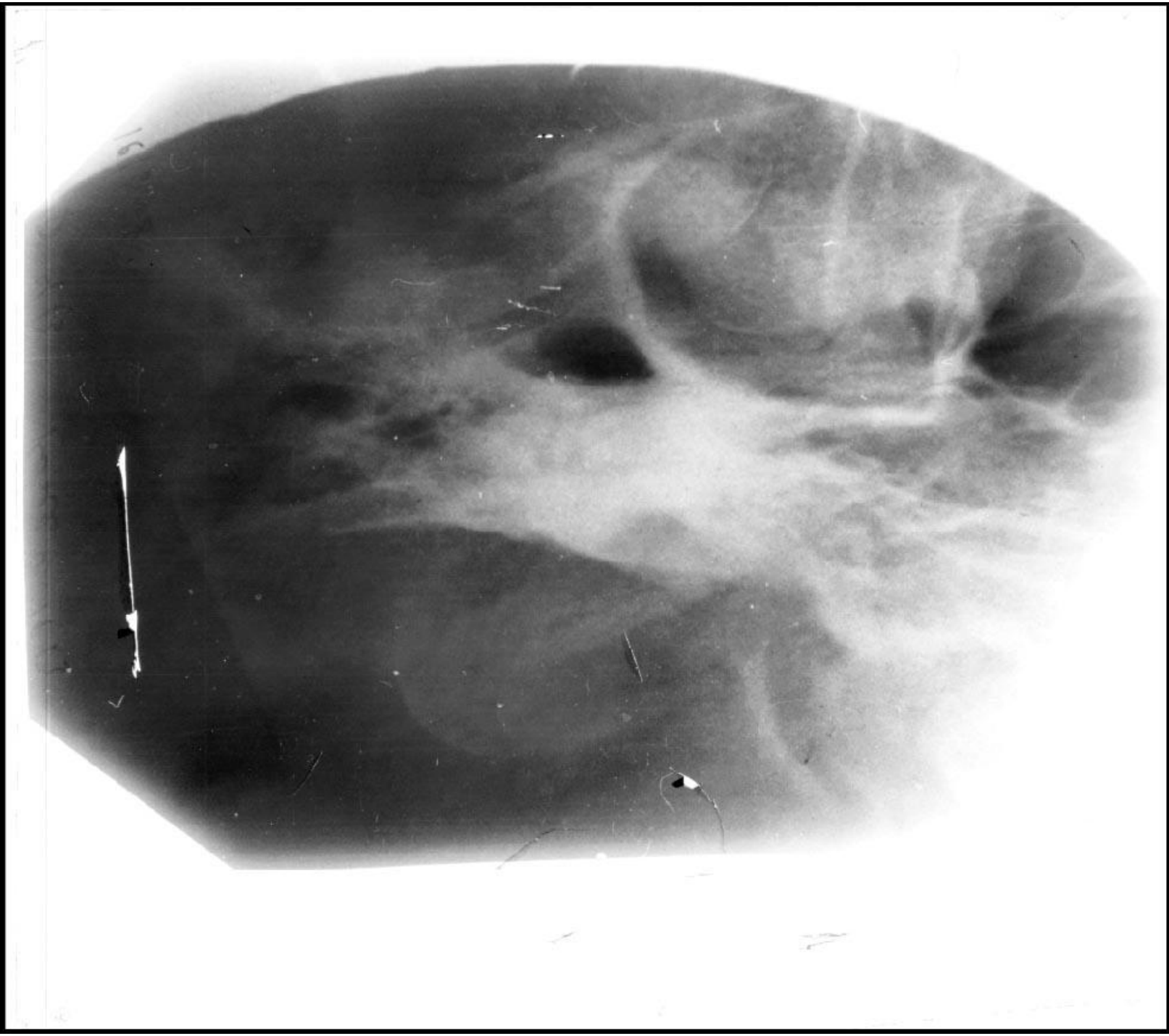
Radiographs in the Stenver view







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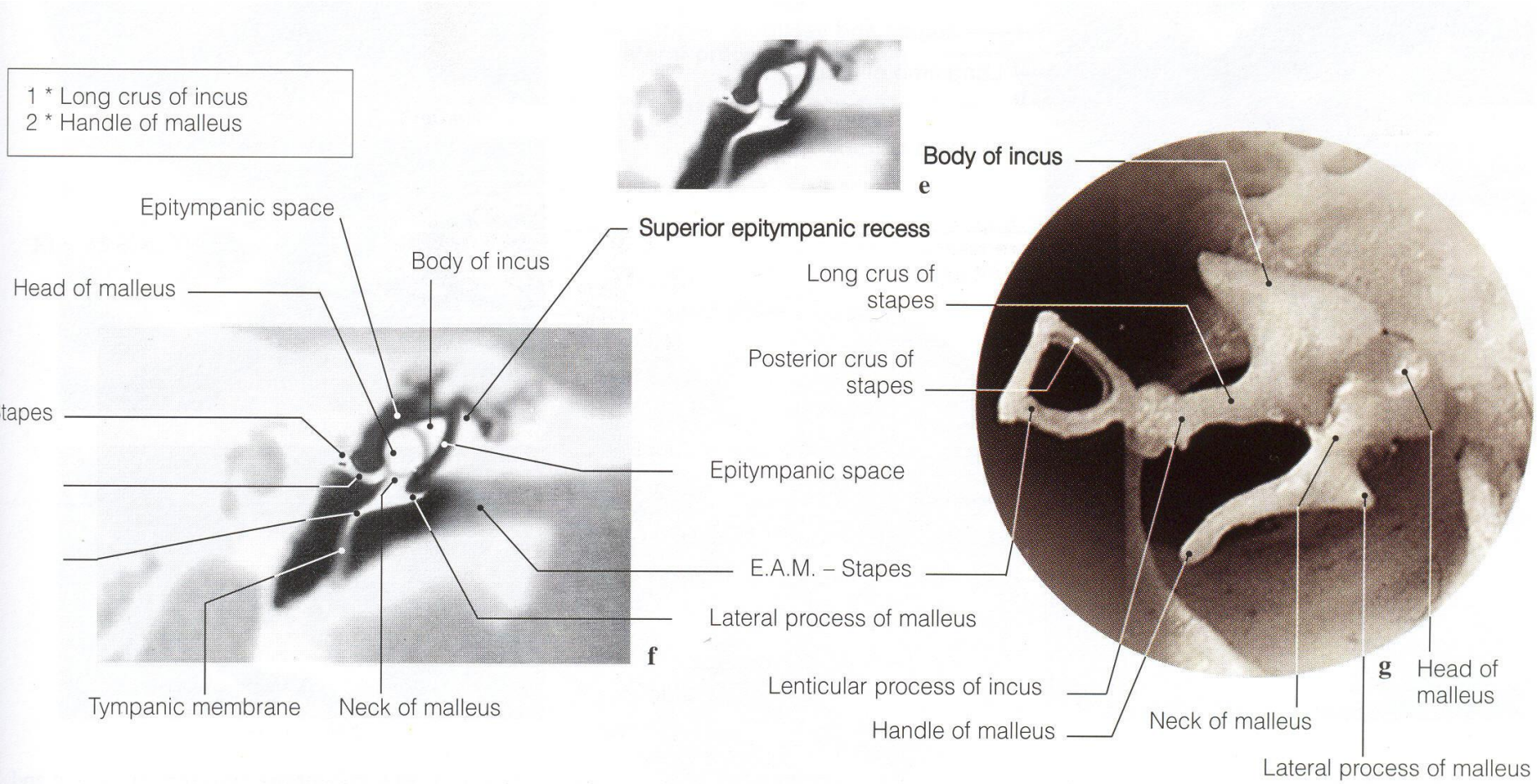
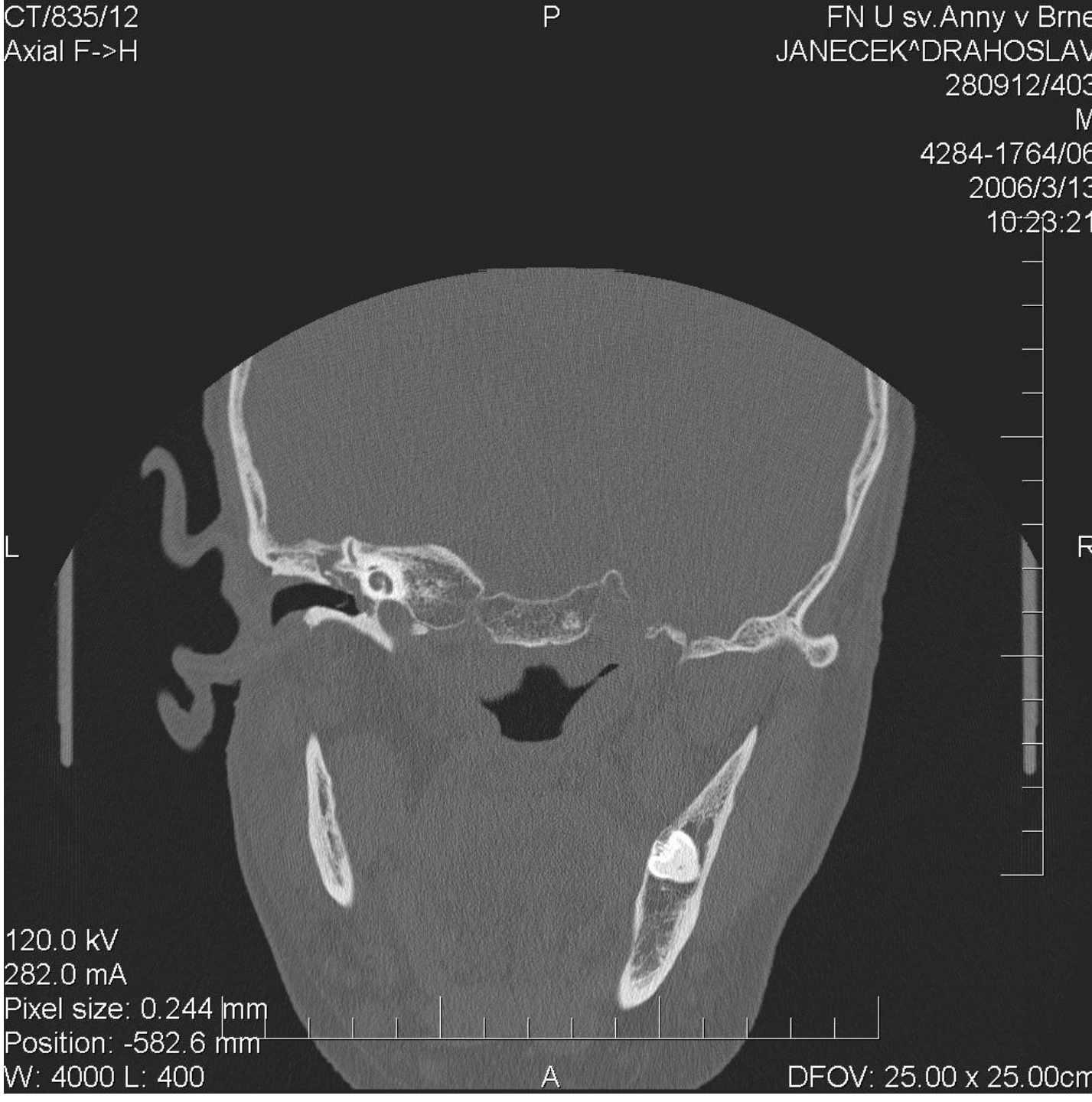
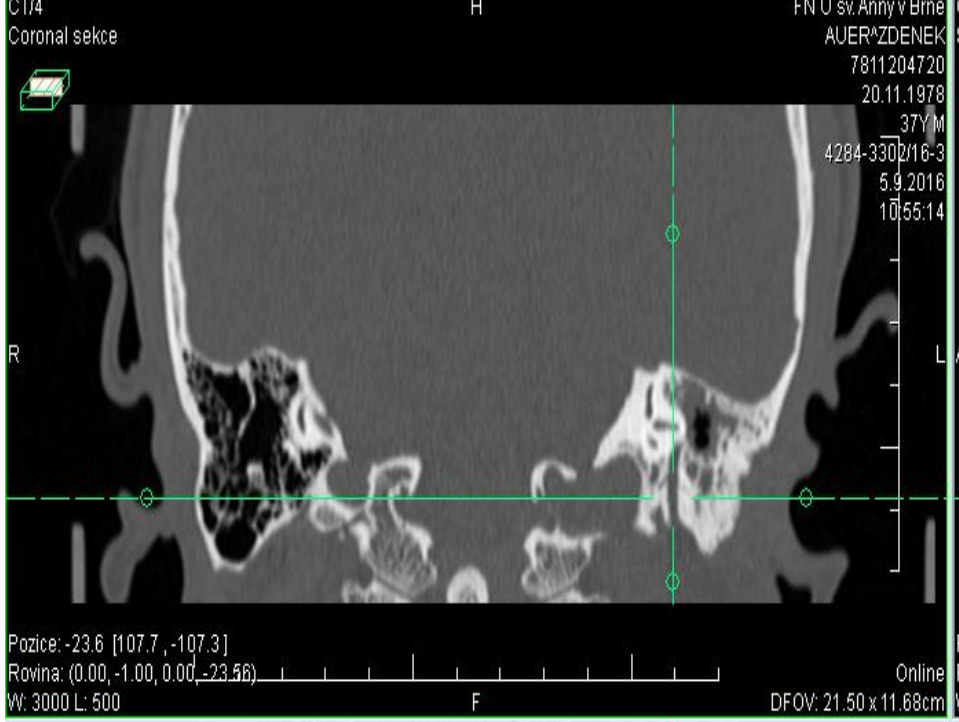
Schema of CT of ossicular chain and middle ear cavity



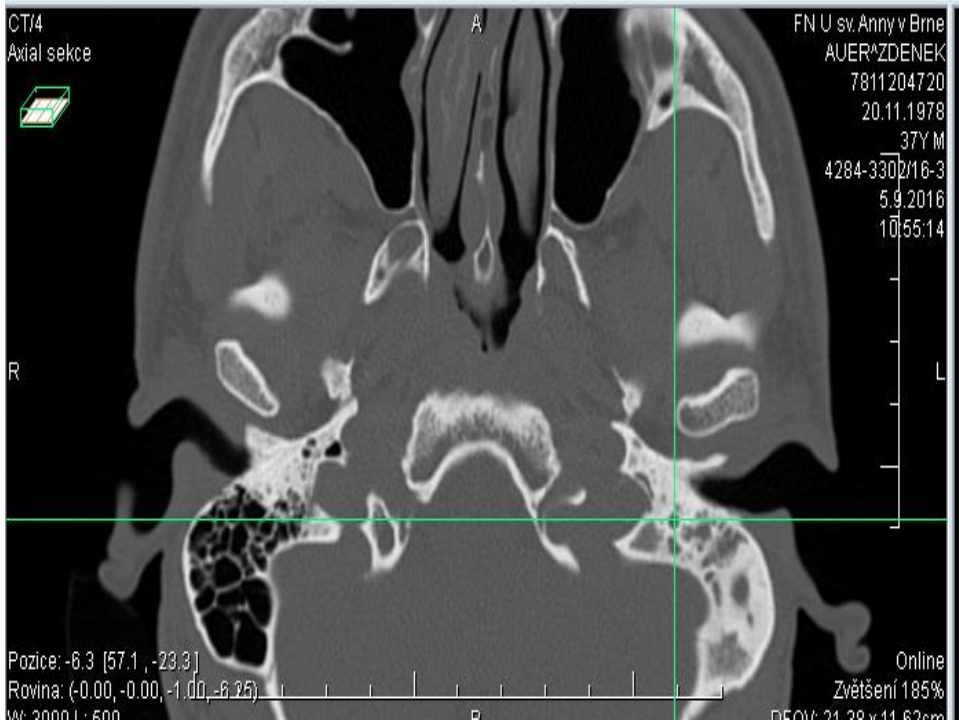
FAKULTNÍ NEMOCNICE U SV. ANNY V BRNĚ



Canalis Fallopi


CT/4
H
FN U sv. Anny v Brne
Coronal sekce
AUER^ZDENEK
7811204720
20.11.1978
37Y M
4284-3302/16-3
5.9.2016
10:55:14
R
L
Pozice: -23.6 [107.7 , -107.3]
Rovina: (0.00, -1.00, 0.00, -23.56)
Online
W: 3000 L: 500
F
DFOV: 21.50 x 11.68cm


CT/4
H
FN U sv. Anny v Brne
Sagittal sekce
AUER^ZDENEK
7811204720
20.11.1978
37Y M
4284-3302/16-3
5.9.2016
10:55:14
A
P
Pozice: -44.6 [107.7 , -107.3]
Rovina: (-1.00, 0.00, 0.00, -44.65)
Online
W: 3000 L: 500
F
DFOV: 21.50 x 11.68cm


CT/4
A
FN U sv. Anny v Brne
Axial sekce
AUER^ZDENEK
7811204720
20.11.1978
37Y M
4284-3302/16-3
5.9.2016
10:55:14
R
L
Pozice: -6.3 [57.1 , -23.3]
Rovina: (-0.00, -0.00, -1.00, -6.25)
Online
Zvětšení 185%

PRÁZDNÝ

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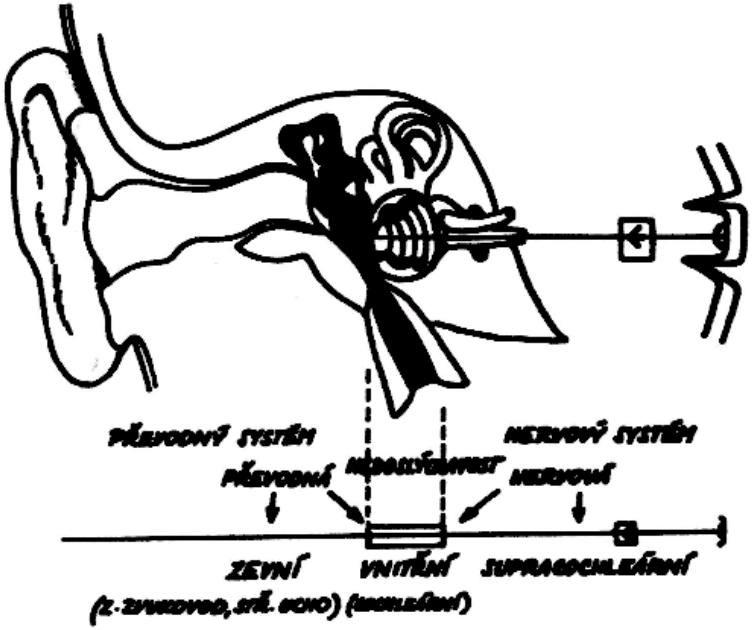
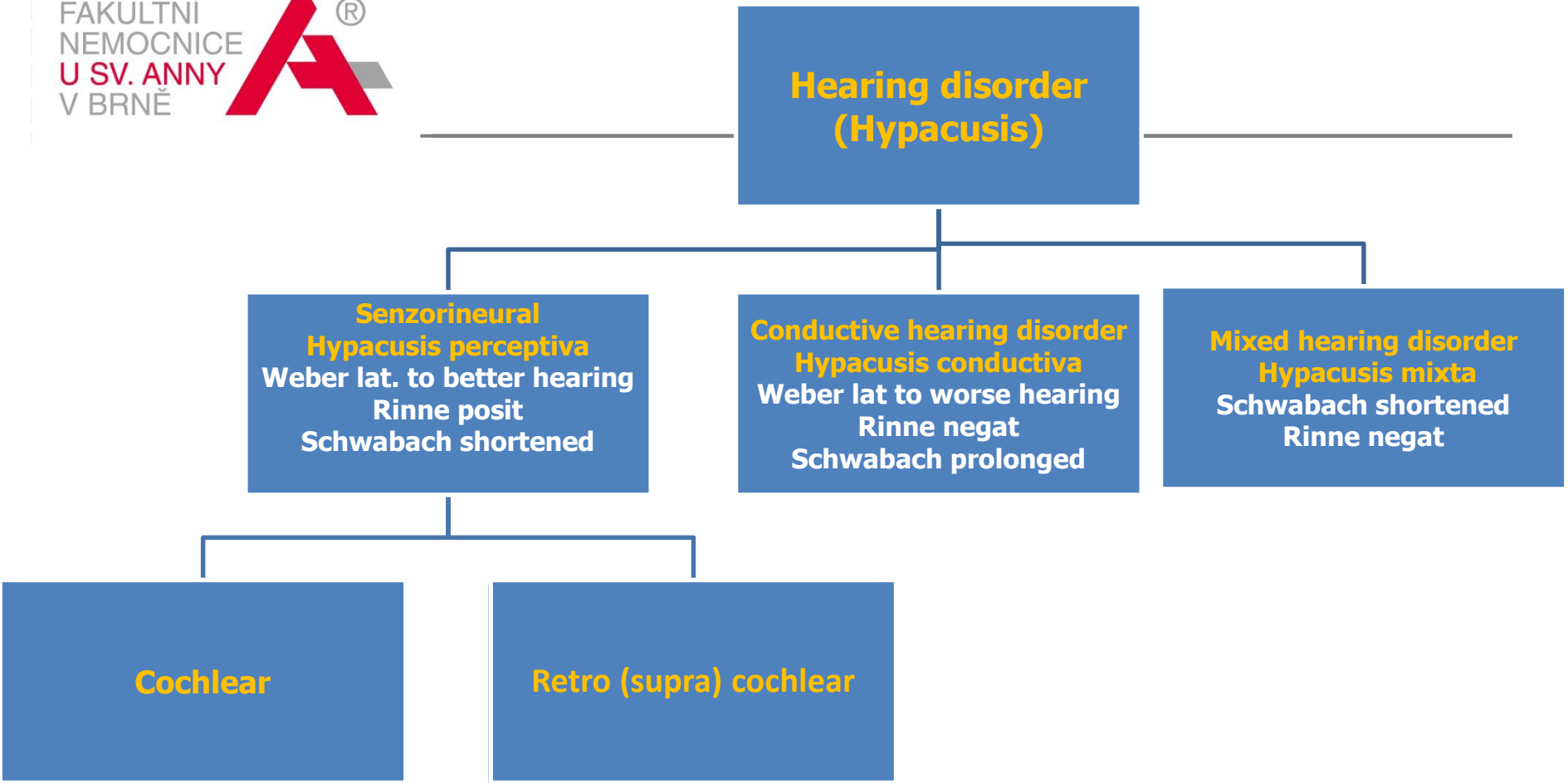
Hearing disorder according to place of lesion

Schema of hearing organ:

- External ear – conductive hearing loss
- Inner ear sensorineural intracochlear hearing disorder
- Central pathways – retro cochlear hearing disorder



FAKULTNÍ NEMOCNICE U SV. ANNY V BRNĚ



Classification of basic type of hearing dysfunction according to place of lesion

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Evaluation of hearing function

We evaluate on growing level of objectivity:

- „Classical“ hearing test
- Audiometry
- Objective evaluating methods
  - tympanometry
  - evoked potentials
  - otoacoustic emissions

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Classical hearing test

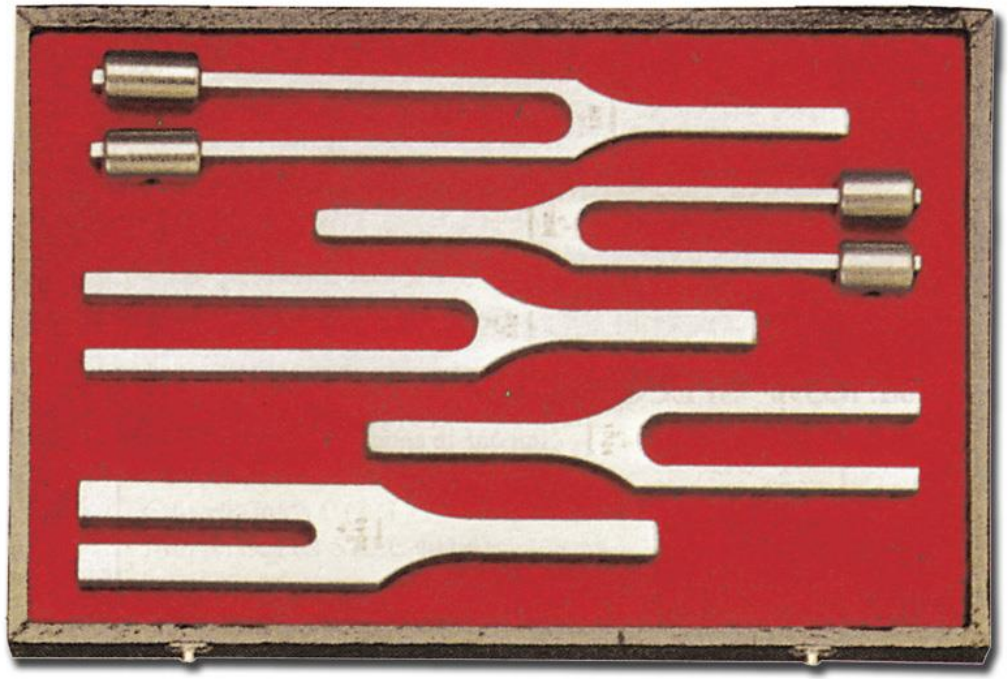
Important part of hearing tests:

- \+ quick, easy, cheap, information about understanding speech
- − only for orientation

Tuning fork tests:

- **Rinne**
- **Weber**
- Schwabach,

  Gellé, …



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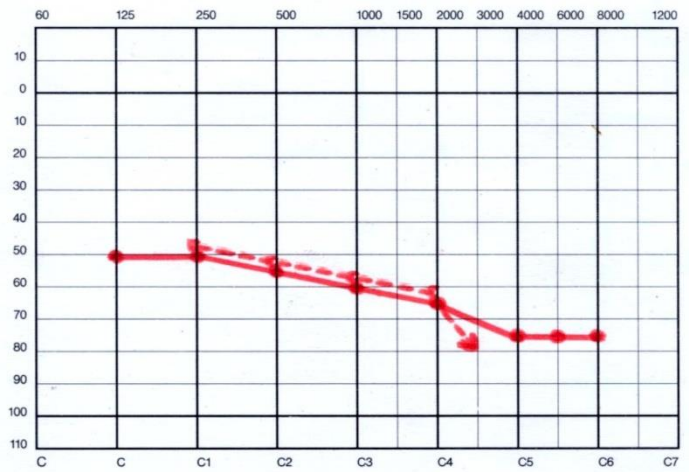
Basic types of hearing disorder

P		L
4	V	10
O,5	Vs	10
	W →	
+	R +	
zkr.	Sch	norm



Hypacusis perceptiva (Sensorineural deafness)

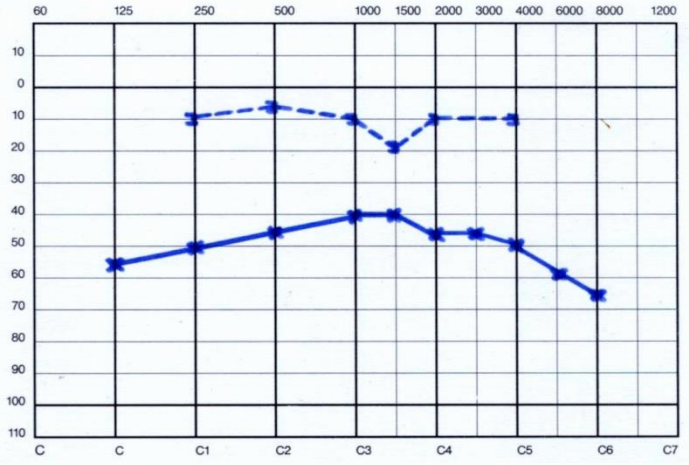
Weber unto better hearing ear

Rinne posit

Schwabach shorter

Retrocochlear

P		L
4	V	10
3	Vs	10
	← W	
—	R +	
prod.	Sch	norm.



Hypacusis conductiva (Conductive hearing loss)

Weber unto worse hearing ear

Rinne negat

Schwabach longer

Hypacusis mixta (Mixed hearing loss)

Schwabach shorter

Rinne negat.

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Pure-tone audiometry

An Audiometer is an electric tone generator used to determine the **hearing threshold** for pure tones; generates tones of specific frequency (Hz) and intensity (dB).

- audiometric room
- Air conduction:

  → headphones
- Bone conduction:

  →bone vibrator

Normal range – until 20 dB loss

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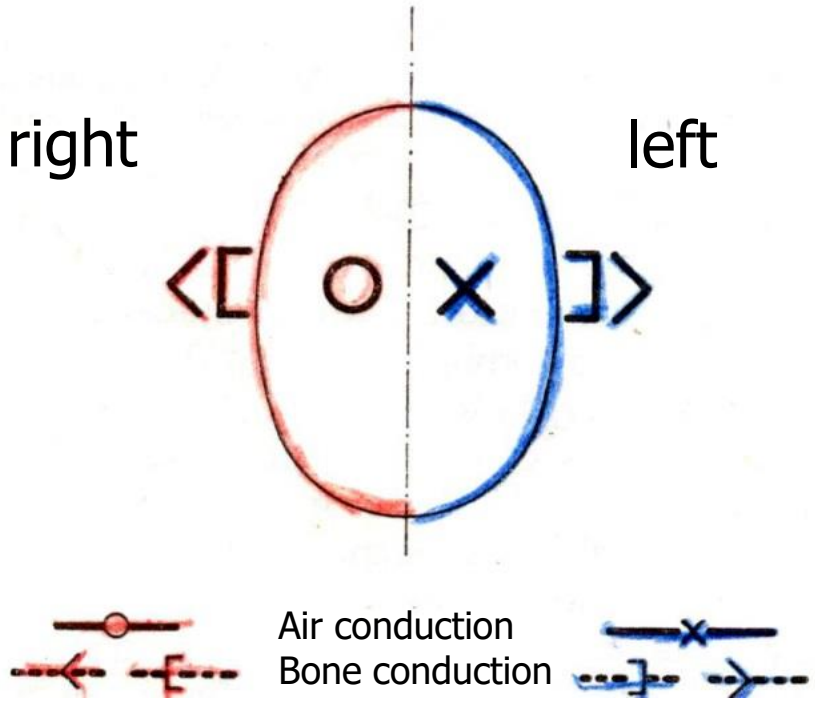
Symbols for record of audiometric evaluation



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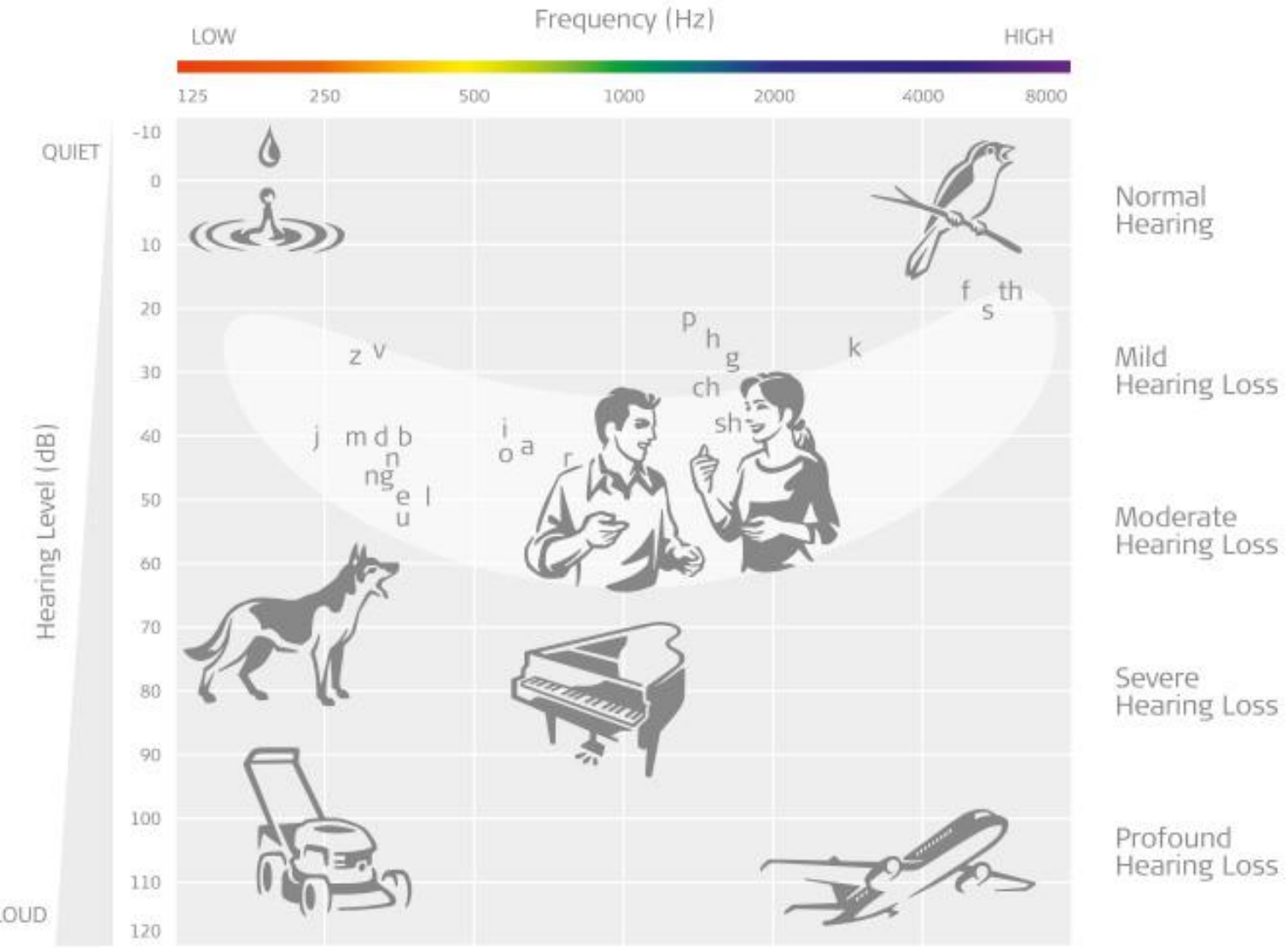
The speech field

Region of the best sensitivity for hearing



AUDIOGRAM

Číslo 1– 5. dubna 2004

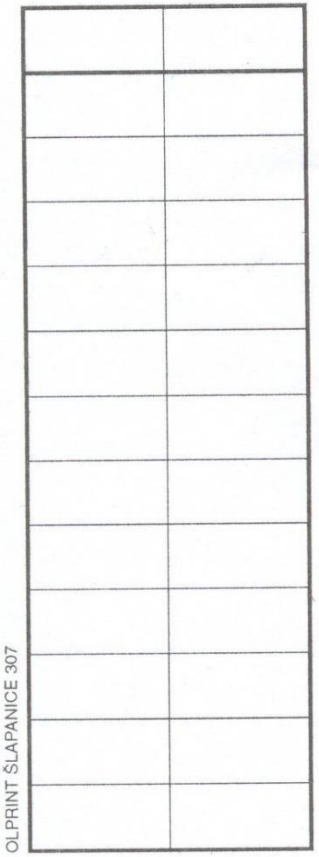
Razítko ústavu:

111

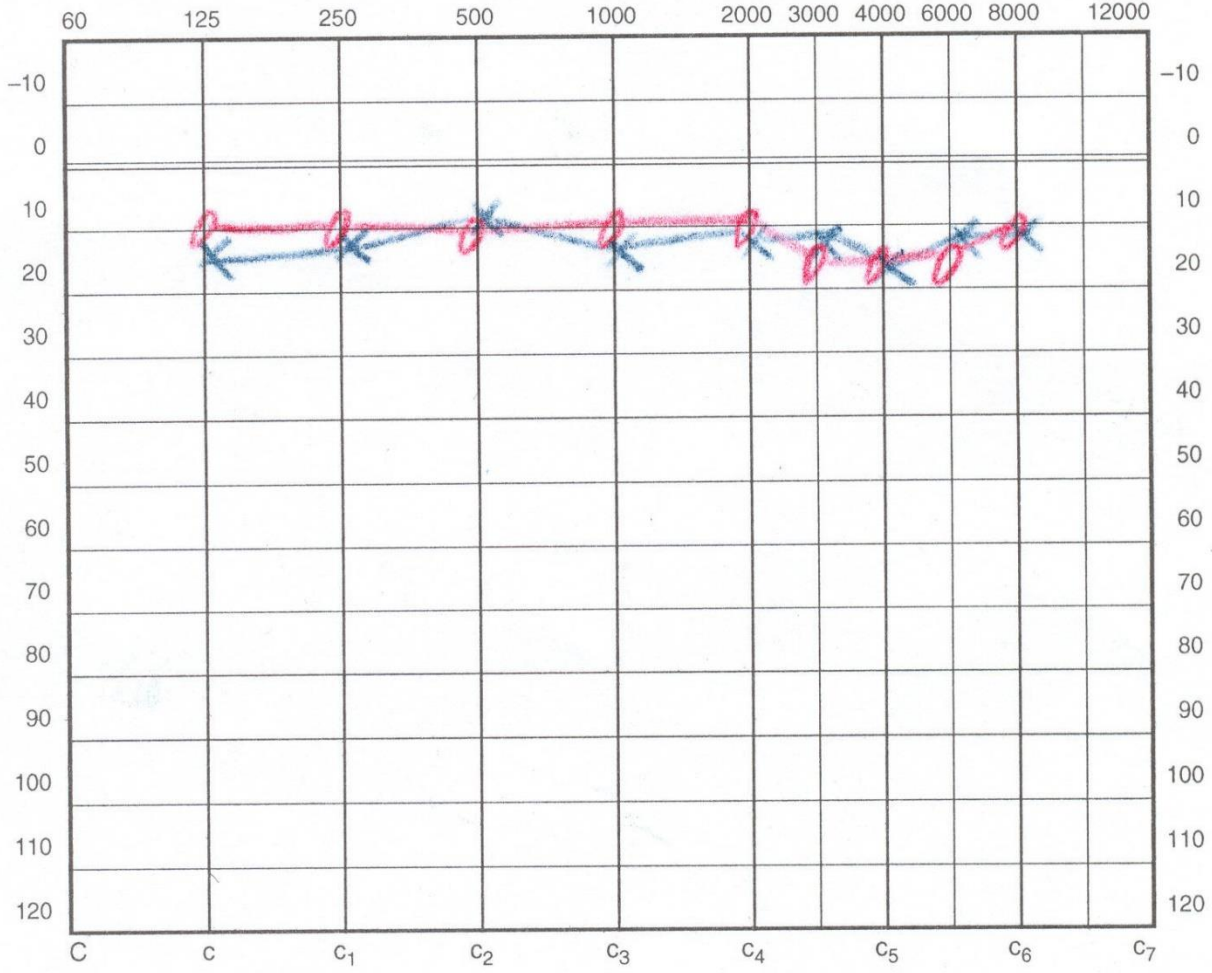
Jméno: ..... Dne ... / ... 20 ...

Bydliště: Adamov rodné č.: .....

Srovnání hlasitosti



Ztráta sluchu v decibelech



Audiometr 40-40

Č. ambulant. protokolu .....

Vedení	vzduchem	kostí
Vpravo	– o –	[
Vlevo	– x –	]

	Vpravo	Vlevo
Ztráta sluchu v %		
Celk. ztráta v %		

Poznámky: .....

Jan I

podpis

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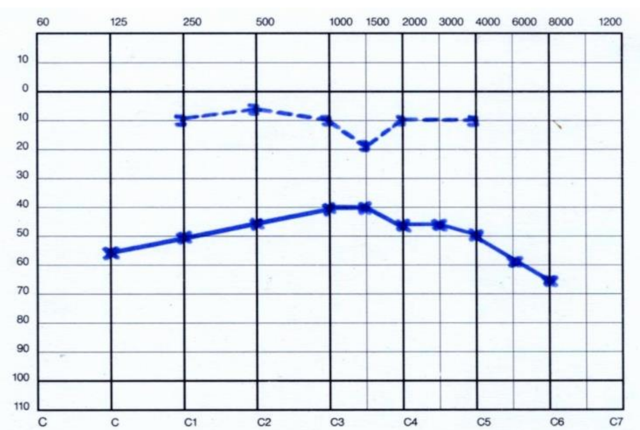
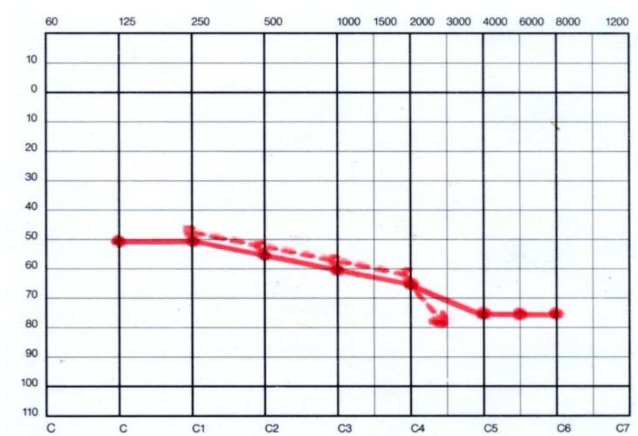
Hearing loss (Hypacusis)

Conductive **Sensorineural** **Mixed**





AUDIOGRAM

Číslo

– 6. dubna 2004

Razítko ústavu:

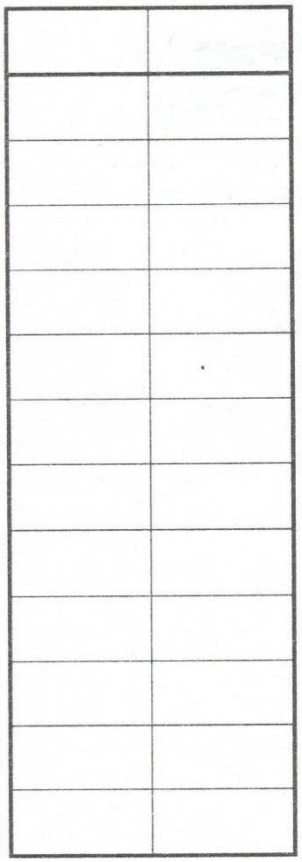
111

Jméno:

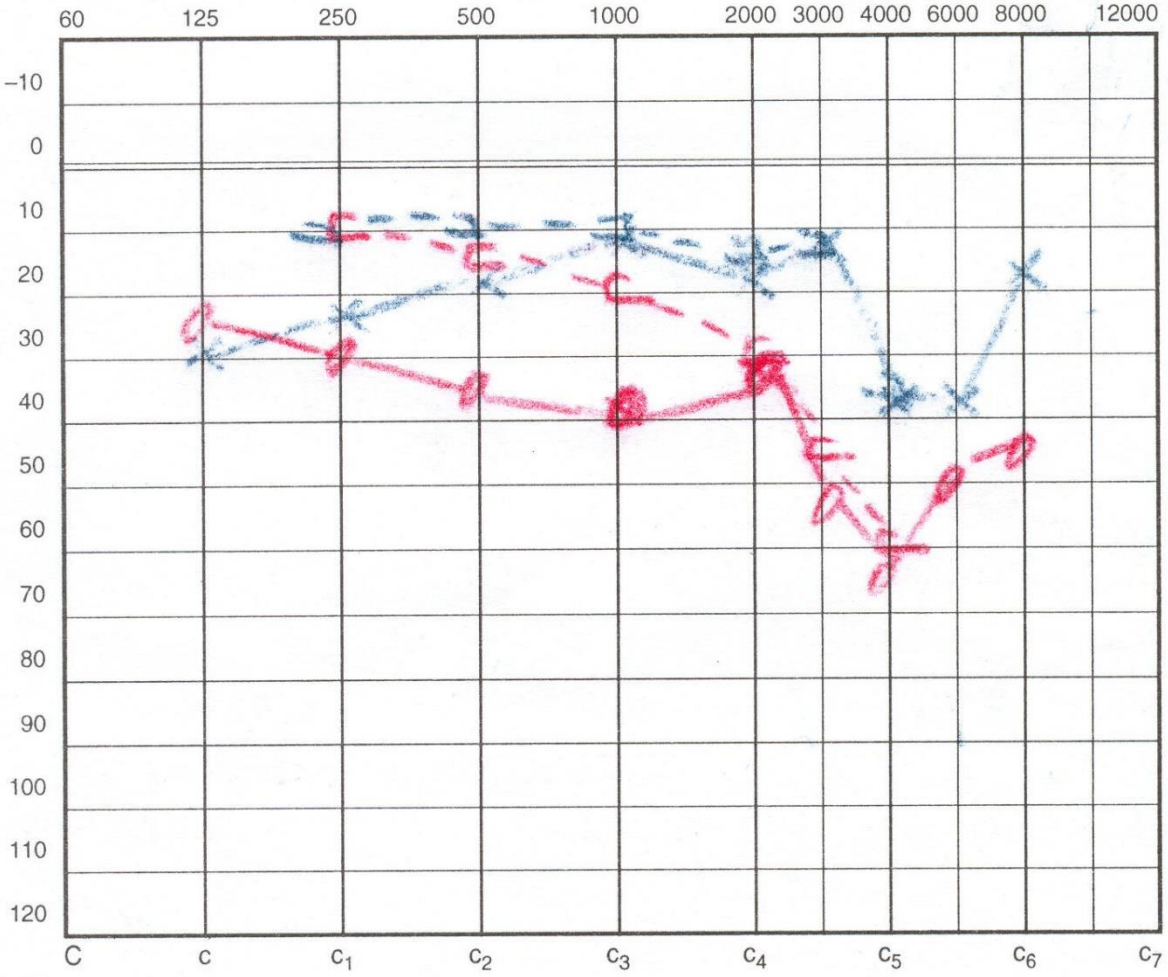
Dne / / 20

Bydliště: IVANICE rodné č.:

Srovnání hlasitosti



Ztráta sluchu v decibelech



Audiometr

AC-40

Č. ambulant. protoko

Vedení	vzdu-chem	kost
Vpravo	– o –	[
Vlevo	– x –	]

	Vpravo	Vlev
Ztráta sluchu v %		
Celk. ztráta v %		

Poznámky:

podpis

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AUDIOGRAM

Číslo

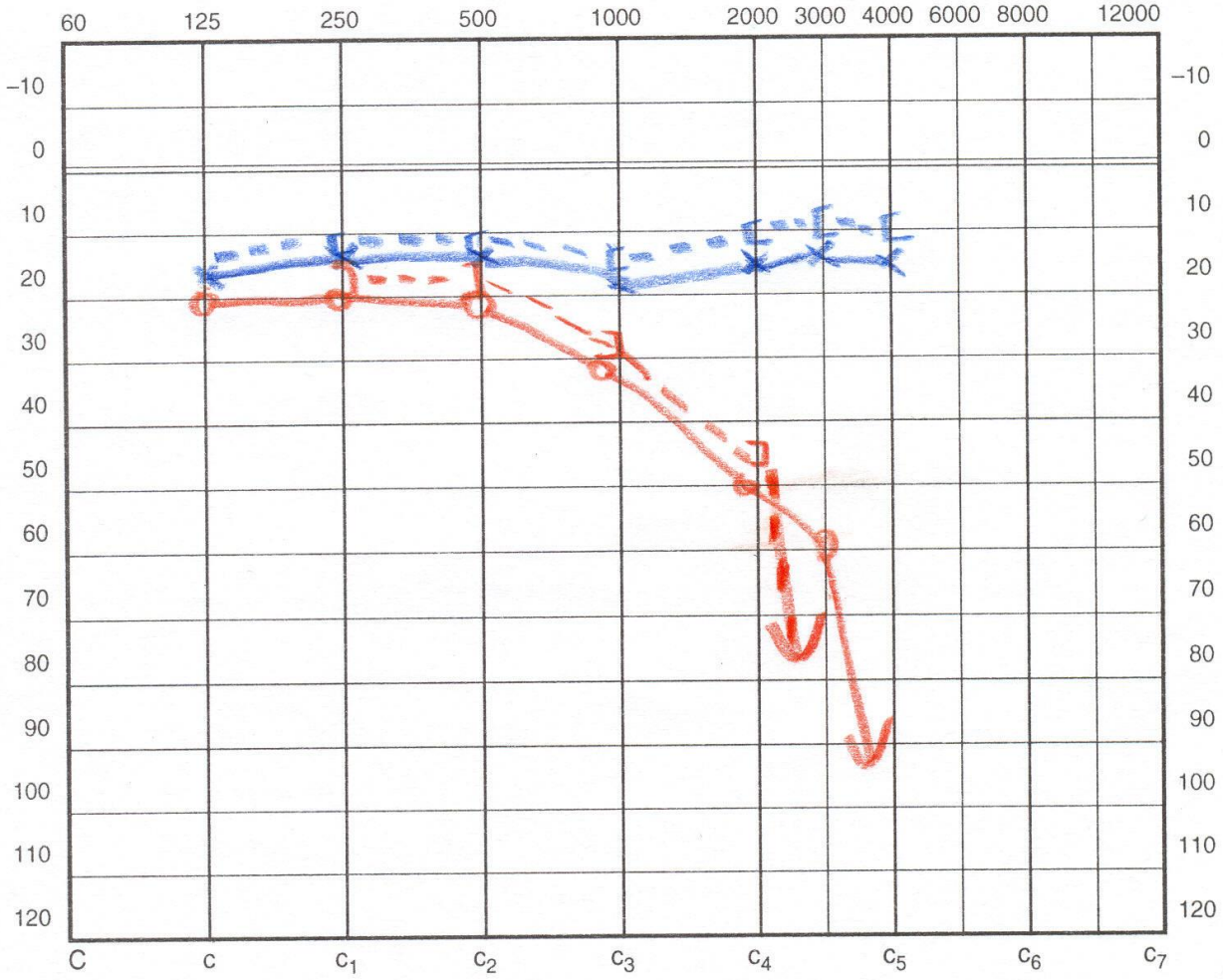
Razítko ústavu:

Jméno: ..... Dne ... / ... 20 ...

Bydliště: ..... rodné č.: .....

Srovnání hlasitosti

Ztráta sluchu v decibelech



Audiometr

..... Č. ambulant. protoko .....

Vedení	vzdu-chem	kost
Vpravo	– o –	[
Vlevo	– x –	]

	Vpravo	Vlev
Ztráta sluchu v %		
Celk. ztráta v %		

Poznámky: .....

..... podpis

AUDIOGRAM

Razítko ústavu:

111

HILAN

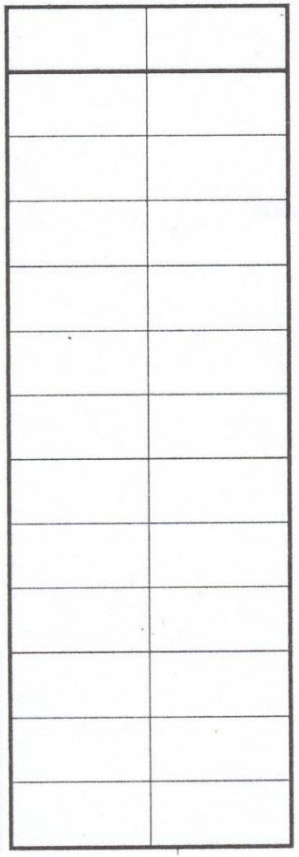
Číslo 2 6. března 2004

Jméno:

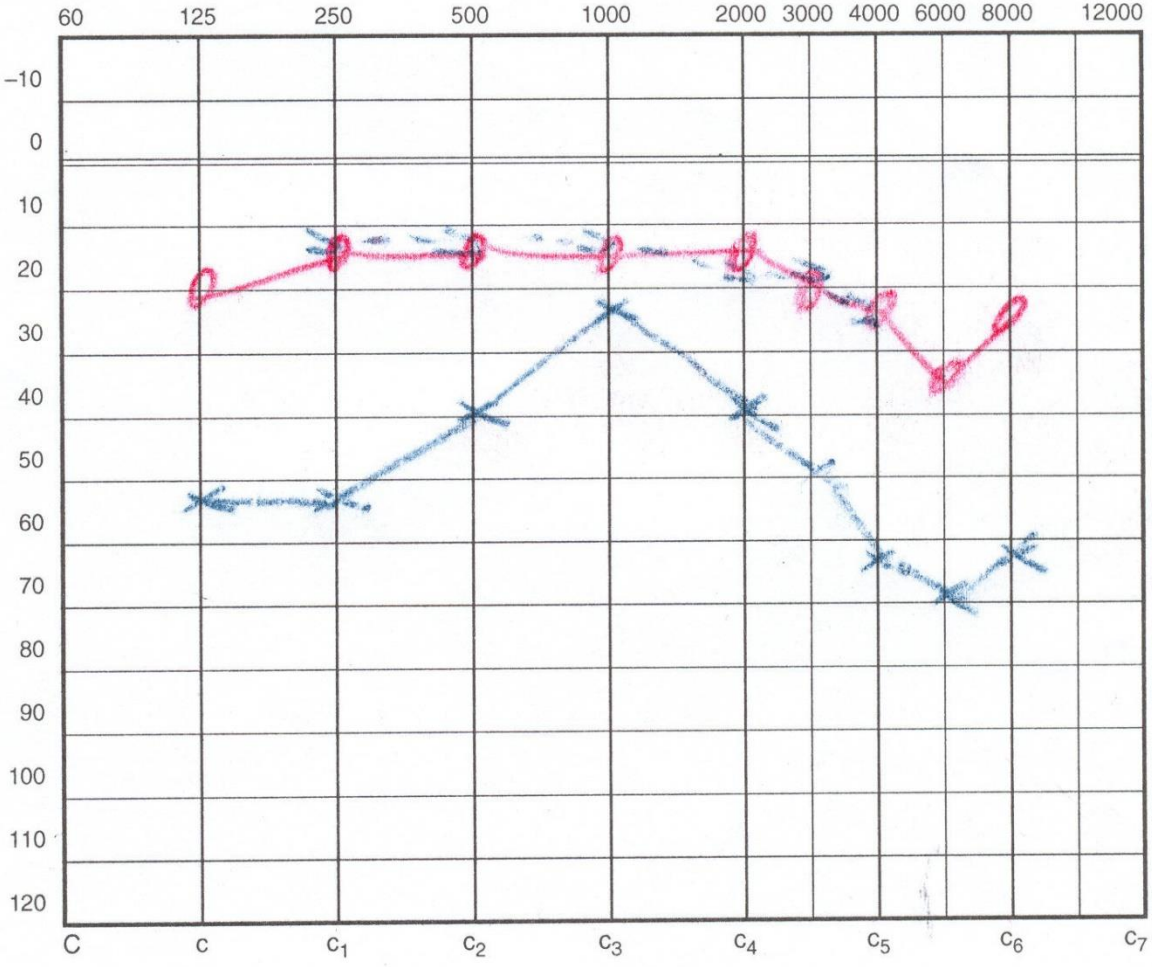
Dne / 20

Bydliště: BRNO rodné č.:

Srovnání hlasitosti



Ztráta sluchu v decibelech



Audiometr AC-40

Č. ambulant. protokolu

Vedení	vzduchem	kostí
Vpravo	– o –	[
Vlevo	– x –	]

	Vpravo	Vlevo
Ztráta sluchu v %		
Celk. ztráta v %		

Poznámky:

podpis

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AUDIOGRAM

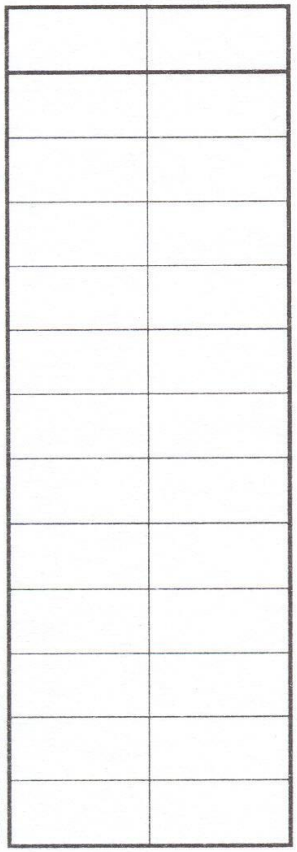
Číslo

Razítko ústavu:

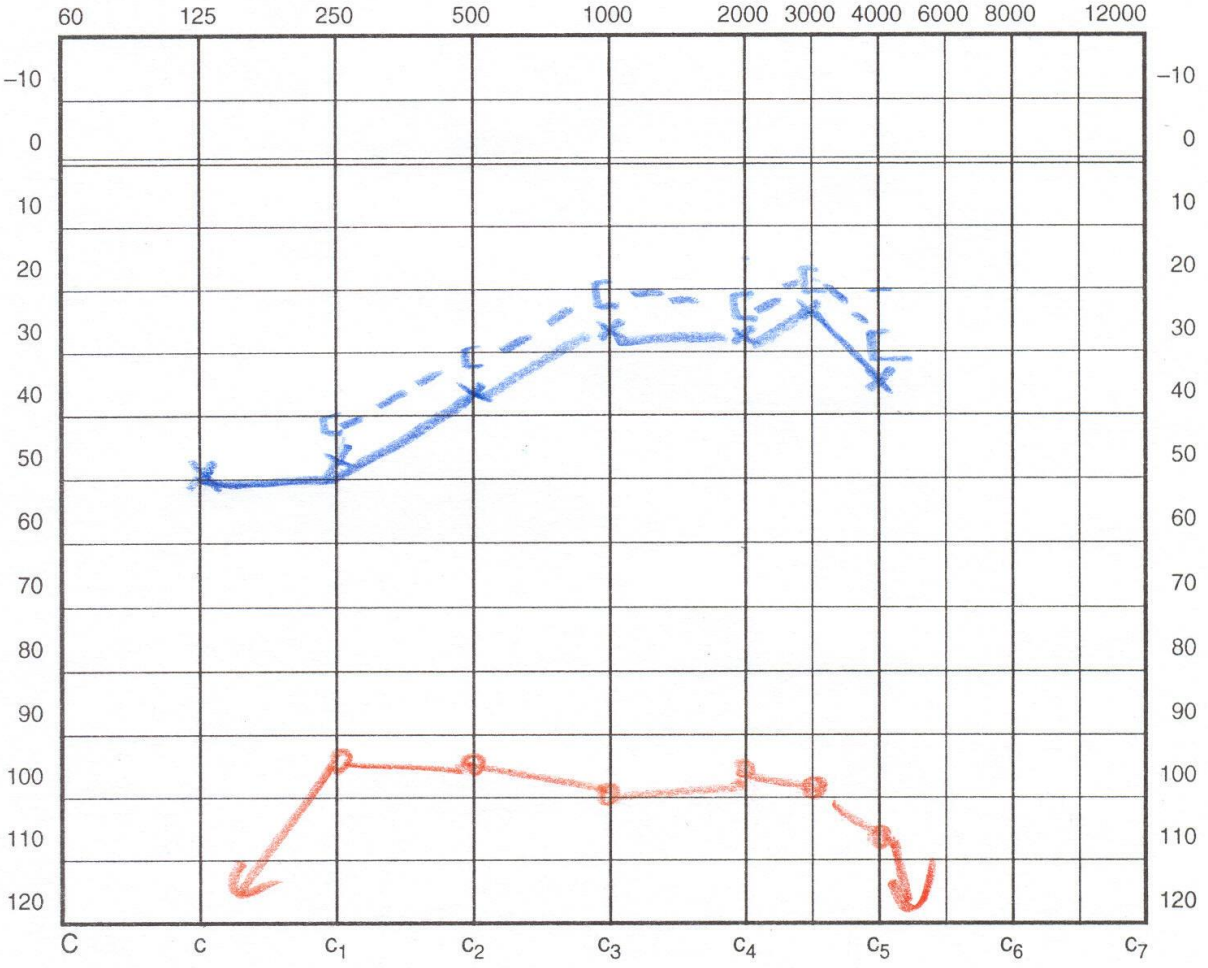
Jméno: ..... Dne ... / ... 20 ...

Bydliště: ..... rodné č.: .....

Srovnání hlasitosti



Ztráta sluchu v decibelech



Audiometr .....

Č. ambulant. protokolu .....

Vedení	vzdu-chem	kostí
Vpravo	– o –	[
Vlevo	– x –	]

	Vpravo	Vlevo
Ztráta sluchu v %		
Celk. ztráta v %		

Poznámky: .....

.....

podpis

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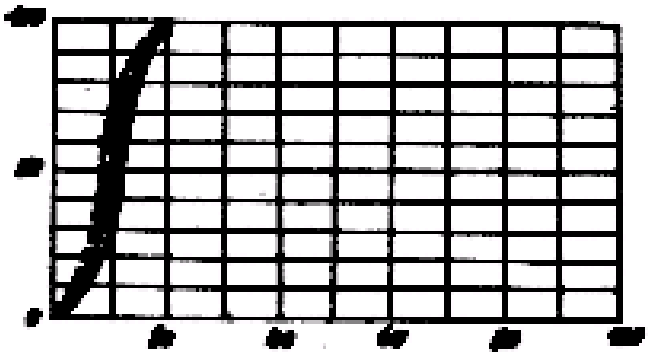
Speech audiometry

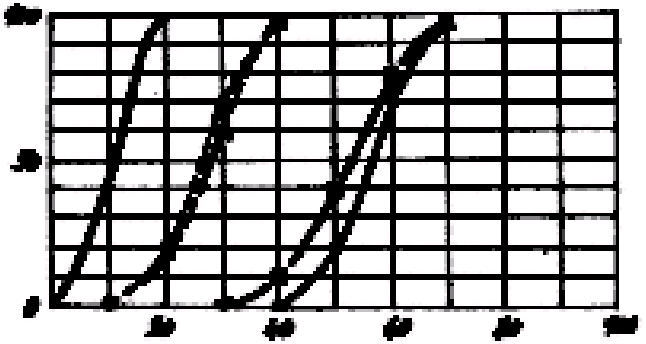
Patient repeats words which are reproduced. One correctly

repeated word means 10% of comprehension from one set. It is evaluated on increasing levels of intensity till 100% of comprehension or maximally possible per cent of comprehension .

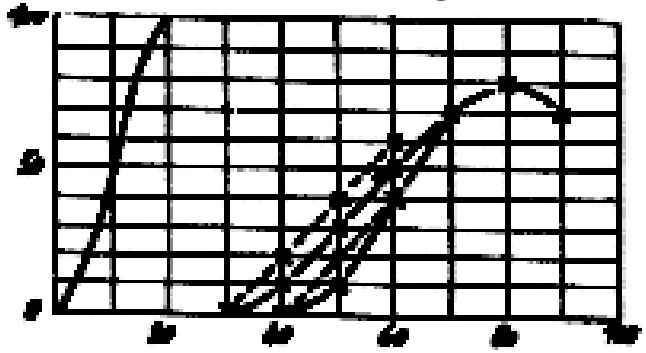
Normal hearing



Conductive hearing loss



Sensorineural hearing loss



Comprehension in %

Speech sound level in %

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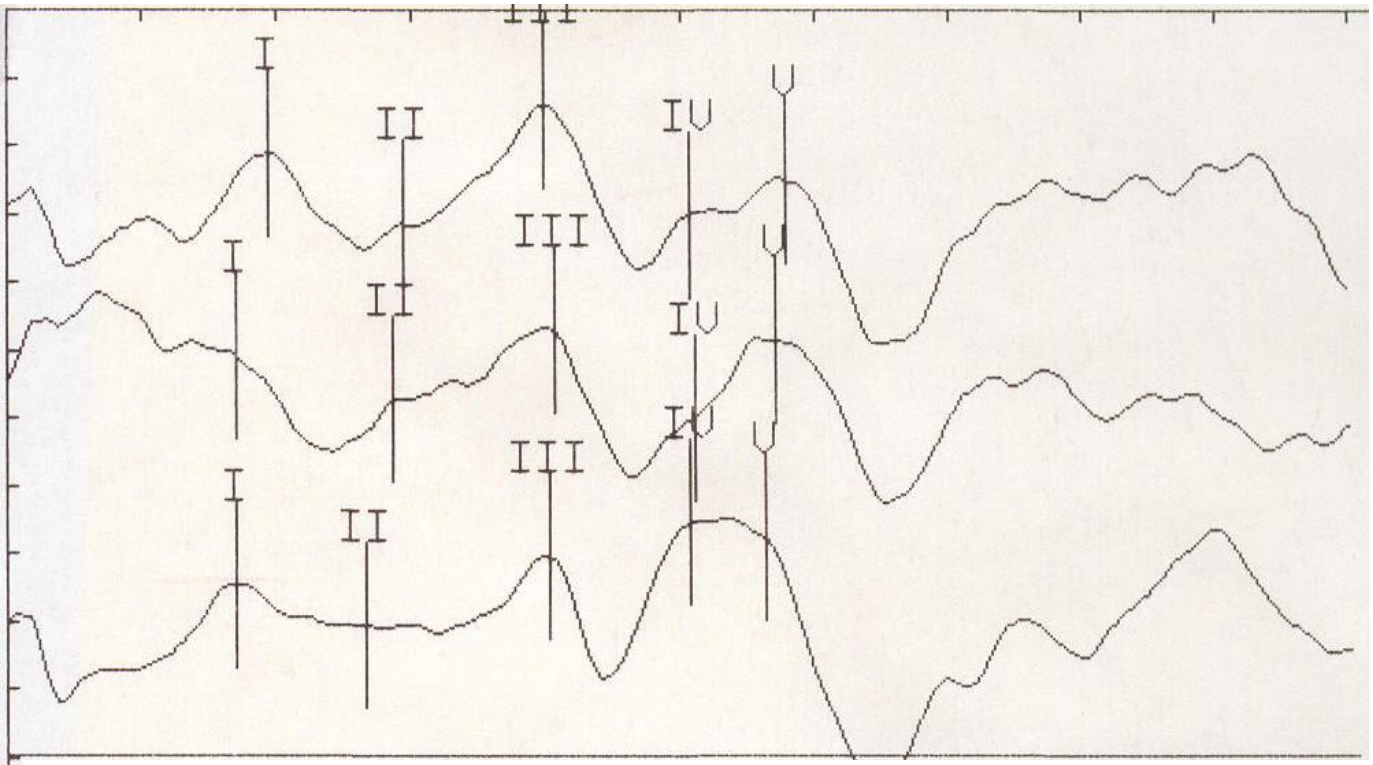
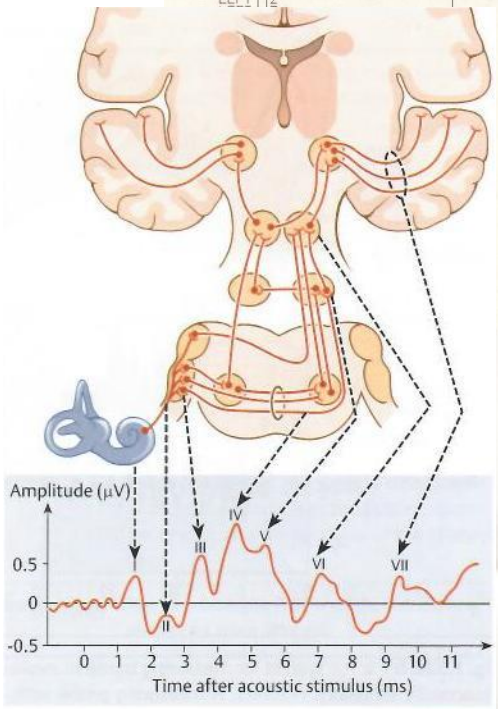
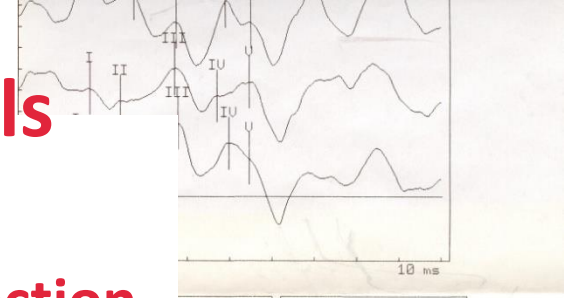
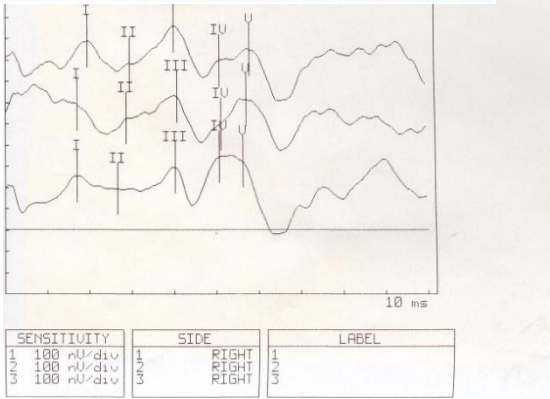
Auditory evoked potentials (BERA,CERA…)

– prolonged latency of 0,2 ms – suspection on small schwanoma n. VIII









Patient repeatedly exposed to an acoustic stimulus, an EEG is recorded. **Averaging** – the individual response can be distinguished by mathematical analysis of numerous individual evoked potentials

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Sensorineural hearing loss

According to type of audiometry curve:

- Basocochlear
- Pankochlear
- Apicocochlear
- Mediocochlear

According to lesion localisation:

- Cochlear
- Retrocochlear

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Cochlear lesion

- bothering, but not life threating

Retrocochlear lesion

- bothering, but also they could life threaten

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Sensorineural hearing loss (intra) cochlear

= damage of cochlear structures

Etiology:

- Presbyacusis
- Heredo-degenerative
- Nois damage
- Toxic damage
- Menier´s disease
- Acute sensorineural hearing loss

… etc.

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Sensorineural hearing loss
retro- (supra-) cochlear

= damage of structures proximal from cochlea

Etiology:

Demyelization	- atherosclerosis - sclerosis multiplex
Inflammation	- borreliosis - neuro-viruses - meningitis - meningoencephalitis
Tumors	-vestibular schwannoma - meningioma - other tumors of cerebellar angle
Trauma	- commotion, contusion - scull base fractures

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Differencial diagnosis cochlear/retrocochlear

1. Subjective tests:

- time demanding
- active cooperation of pt
- complicated for understanding
- relatively low validity

2. Objective tests :

- time usually not so demanding
- demand only passive patient cooperation
- expansive technical equipment
- high validity

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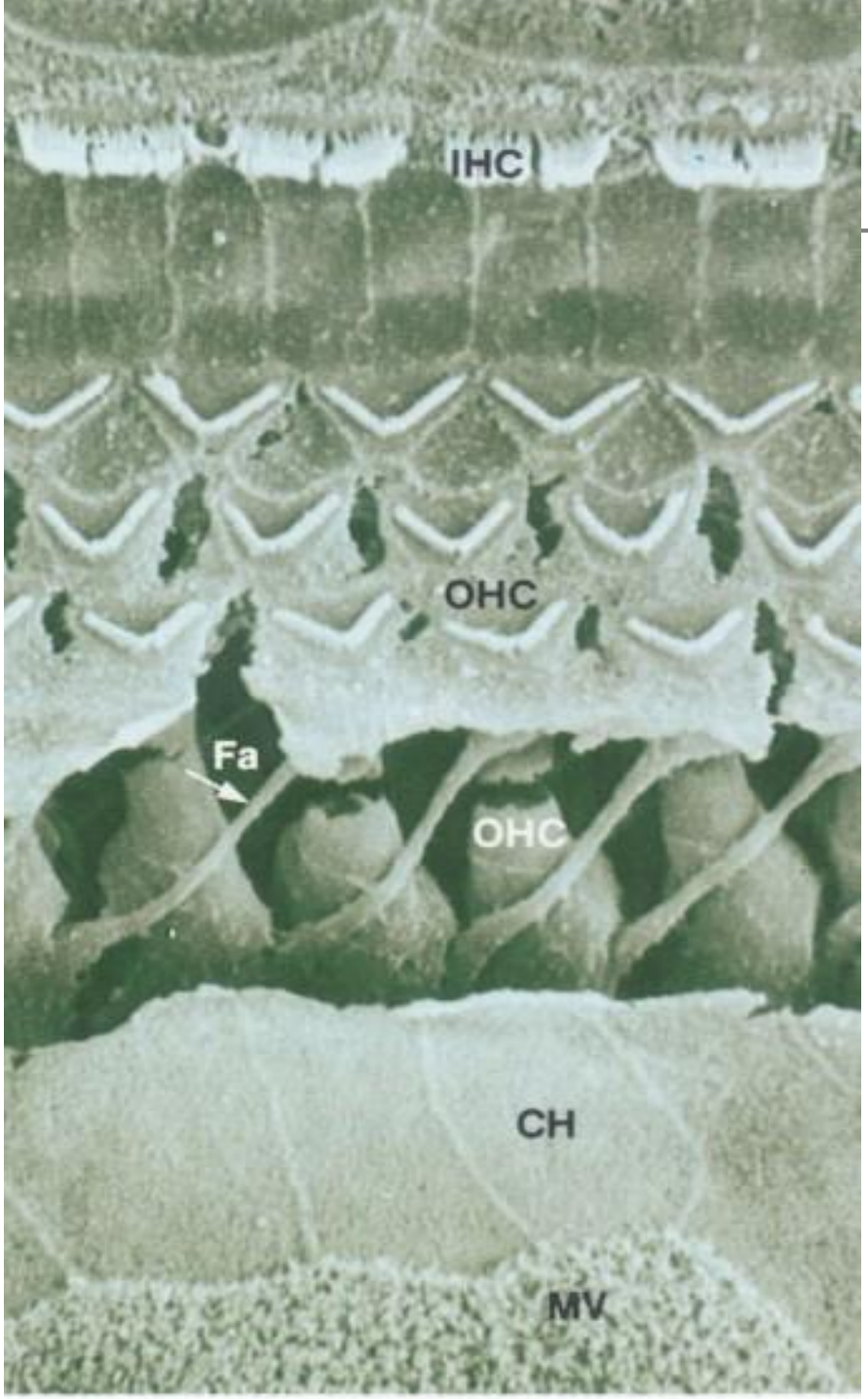
Subjective tests

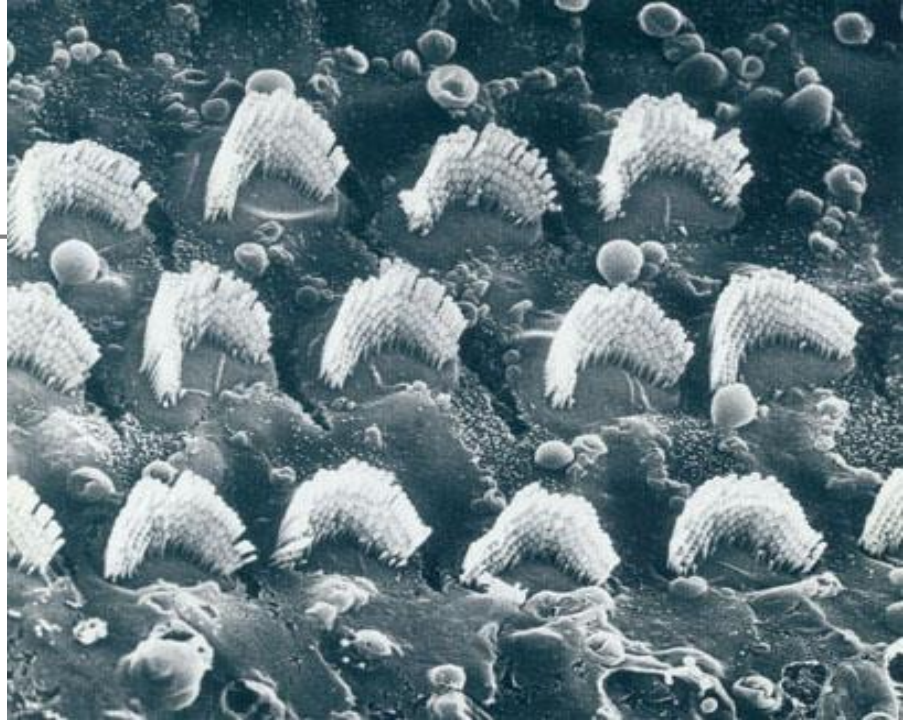
Based on proof of:

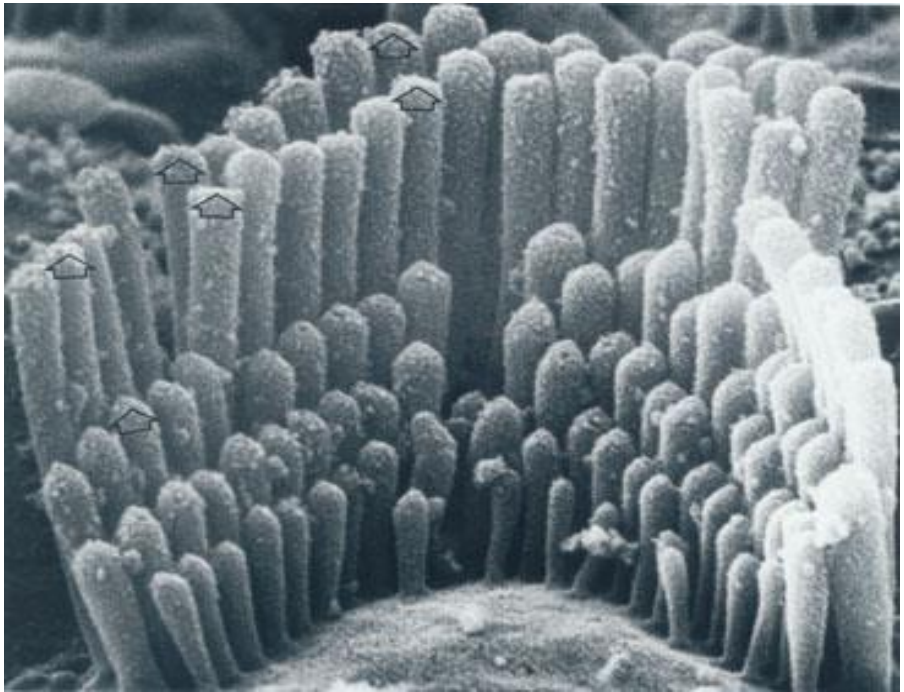
mask effect of noise

recruitment phenomena

wearisomeness of hearing organ


IHC
OHC
Fa
OHC
CH
MV





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Recruitment phenomena

= abnormal increase of loudness in above-threshold in damage of OHC and normal function IHC

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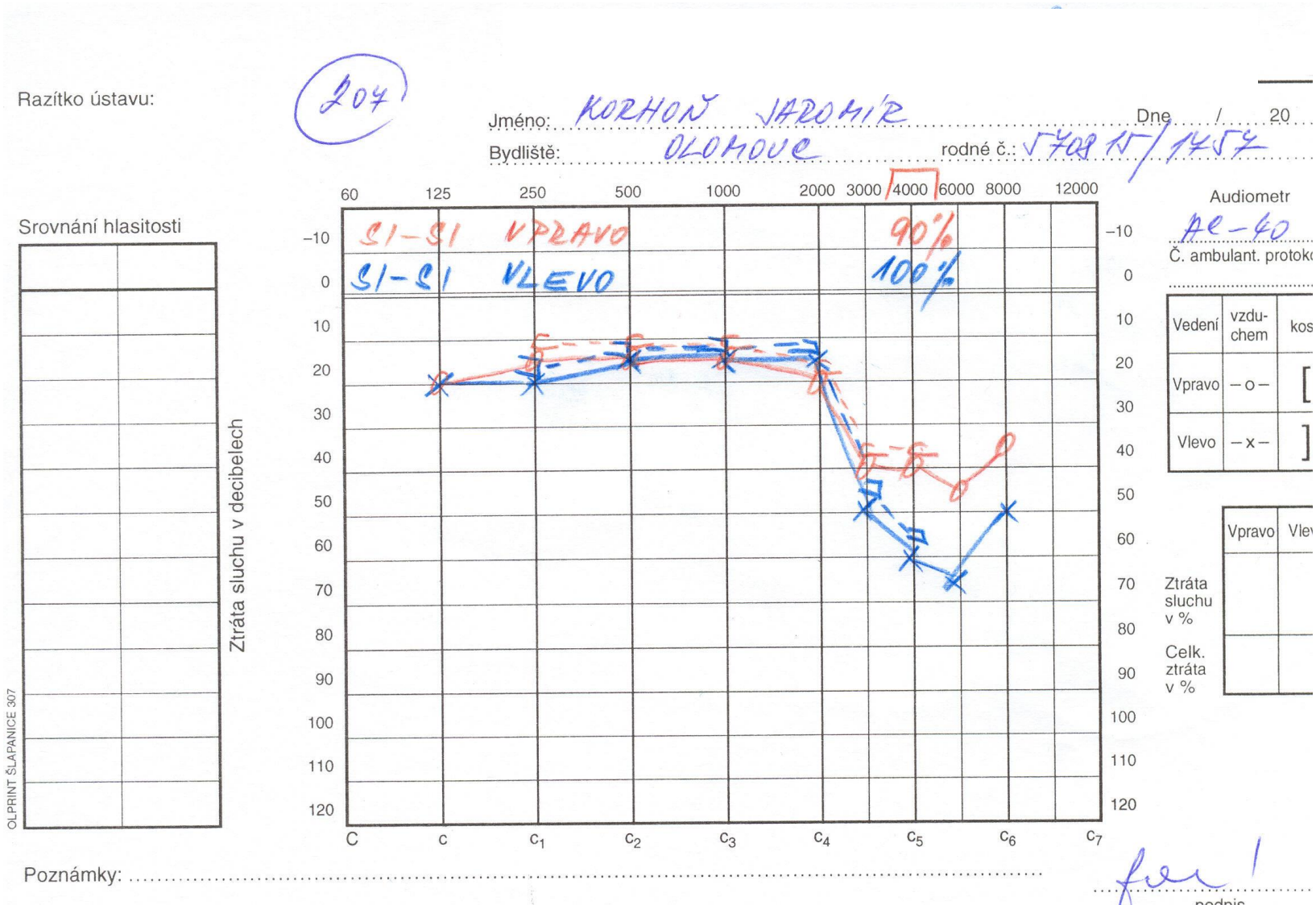
SI-SI Short Increament Sensitivity Index

short time 1 dB increase of intensity 20 dB above treshold (20x)

assuredly recognize



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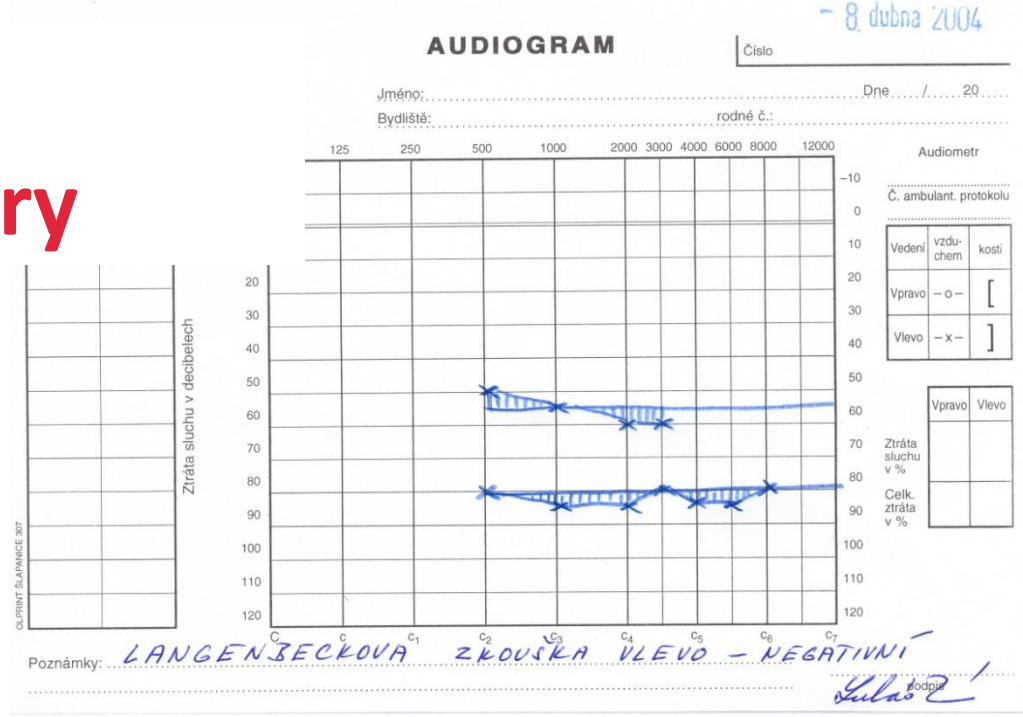
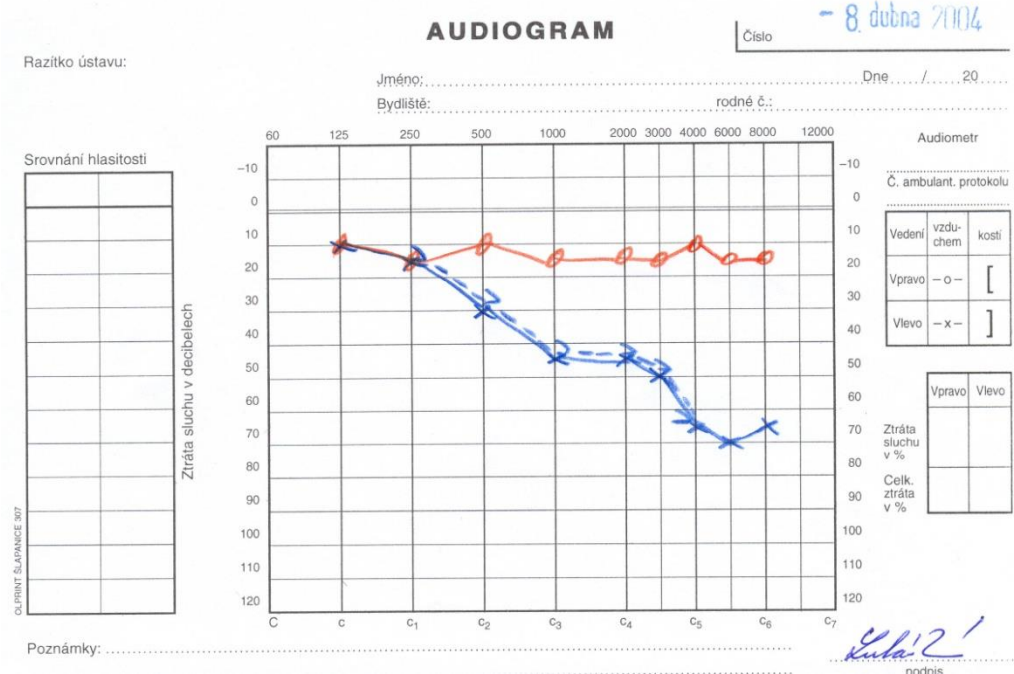
Noise audiometry

Langebeck test

= increase ability to mask tons by hum in supracochlear hearing loss. Thresholds are higher about more than 10 dB as level of ripple.





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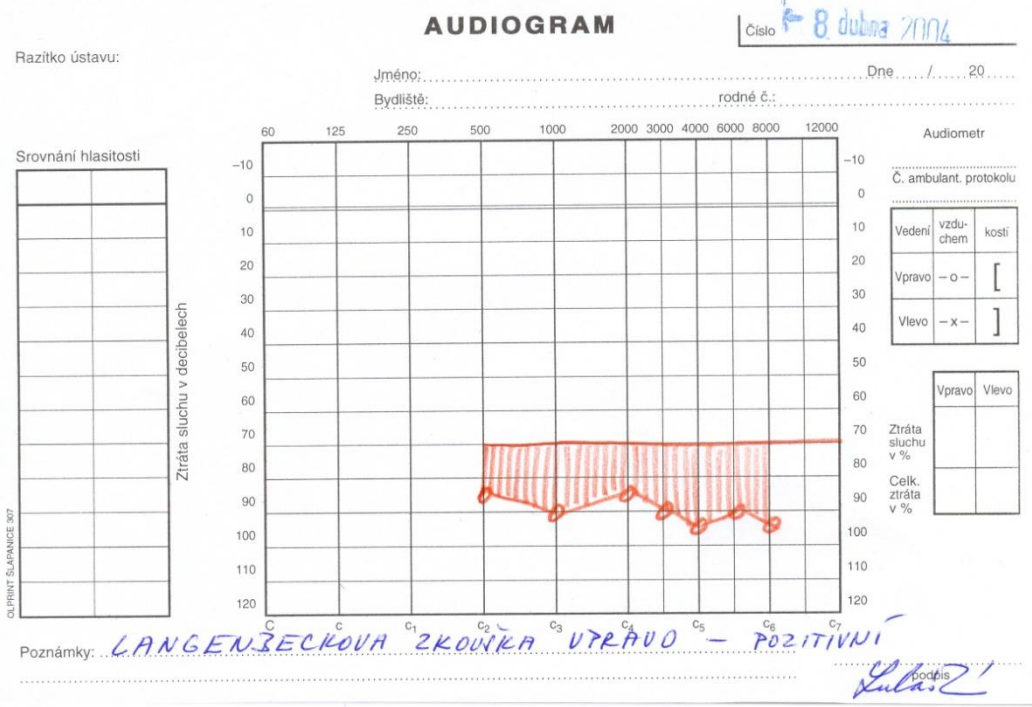
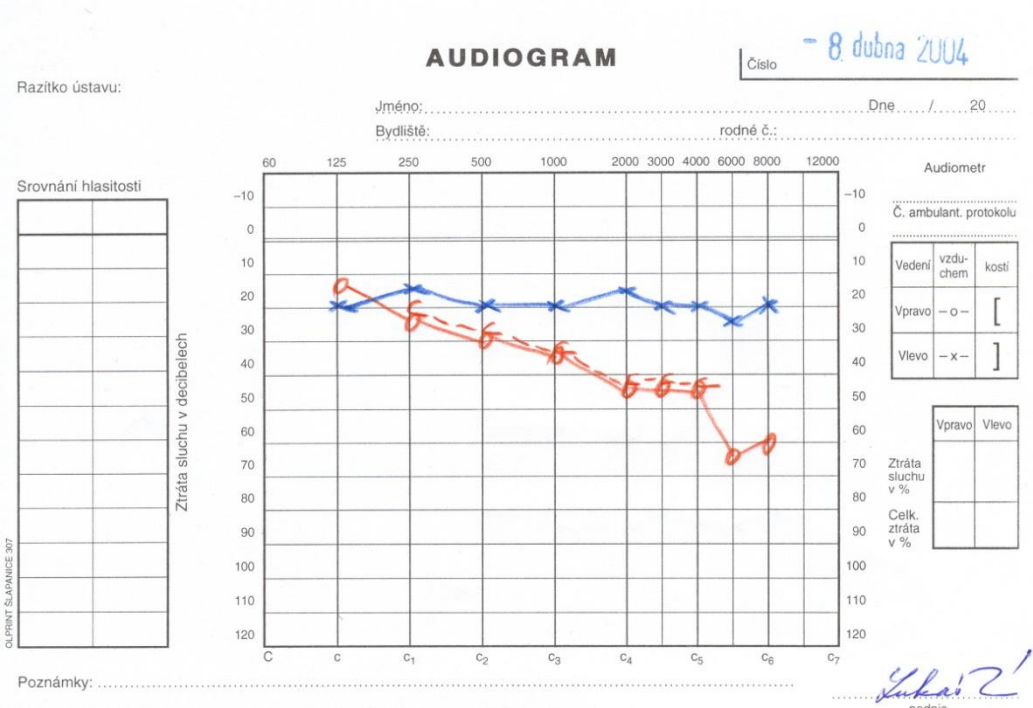
Langebeck test

Supracochlear hearing loss





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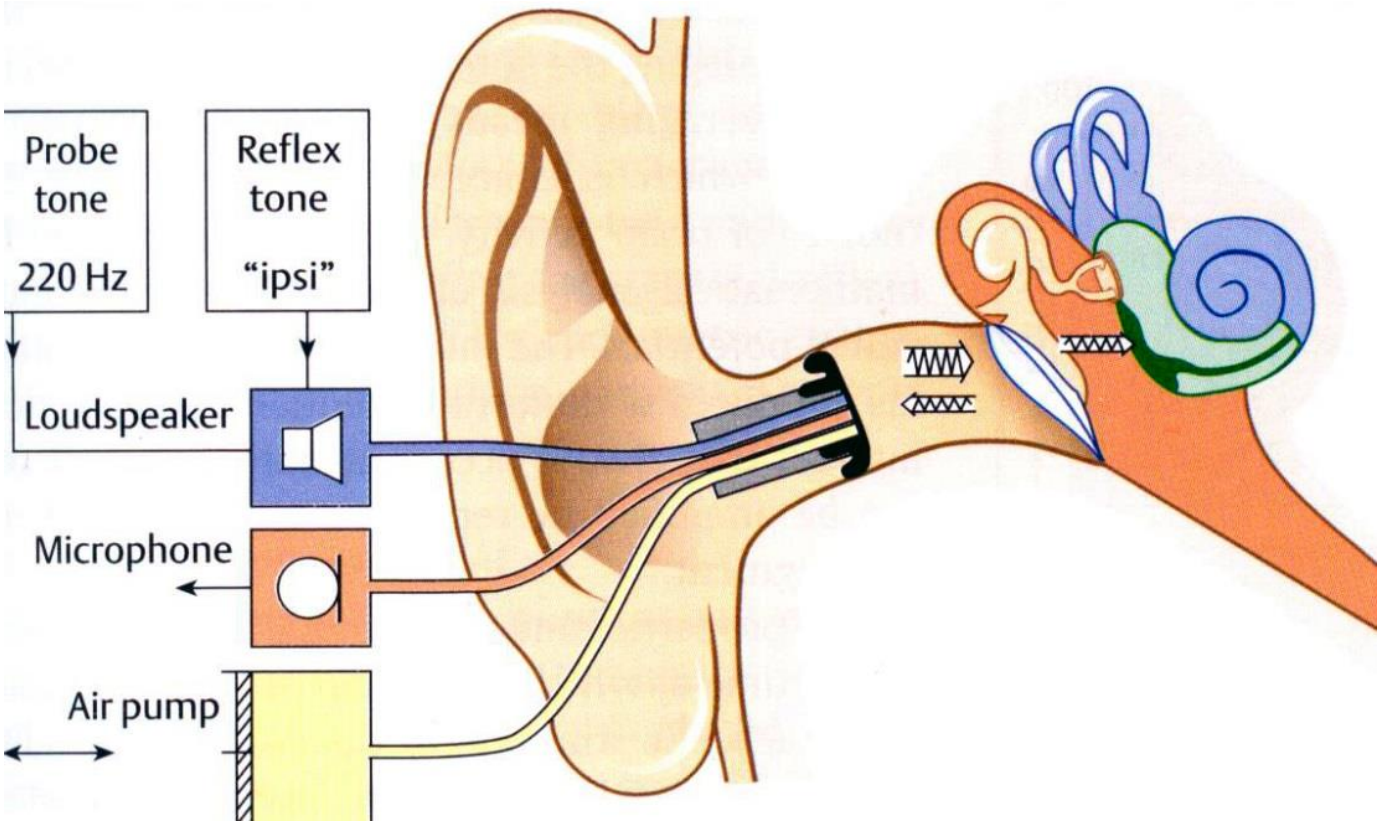
Tympanometry

The greater the pressure differential (before and behind ear drum), the greater is the impedance of tympanic membrane and **more acoustic energy is reflected back** into external meatus. The level of testing tone in meatus is measured by sensitive microphone .



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Tympanometry