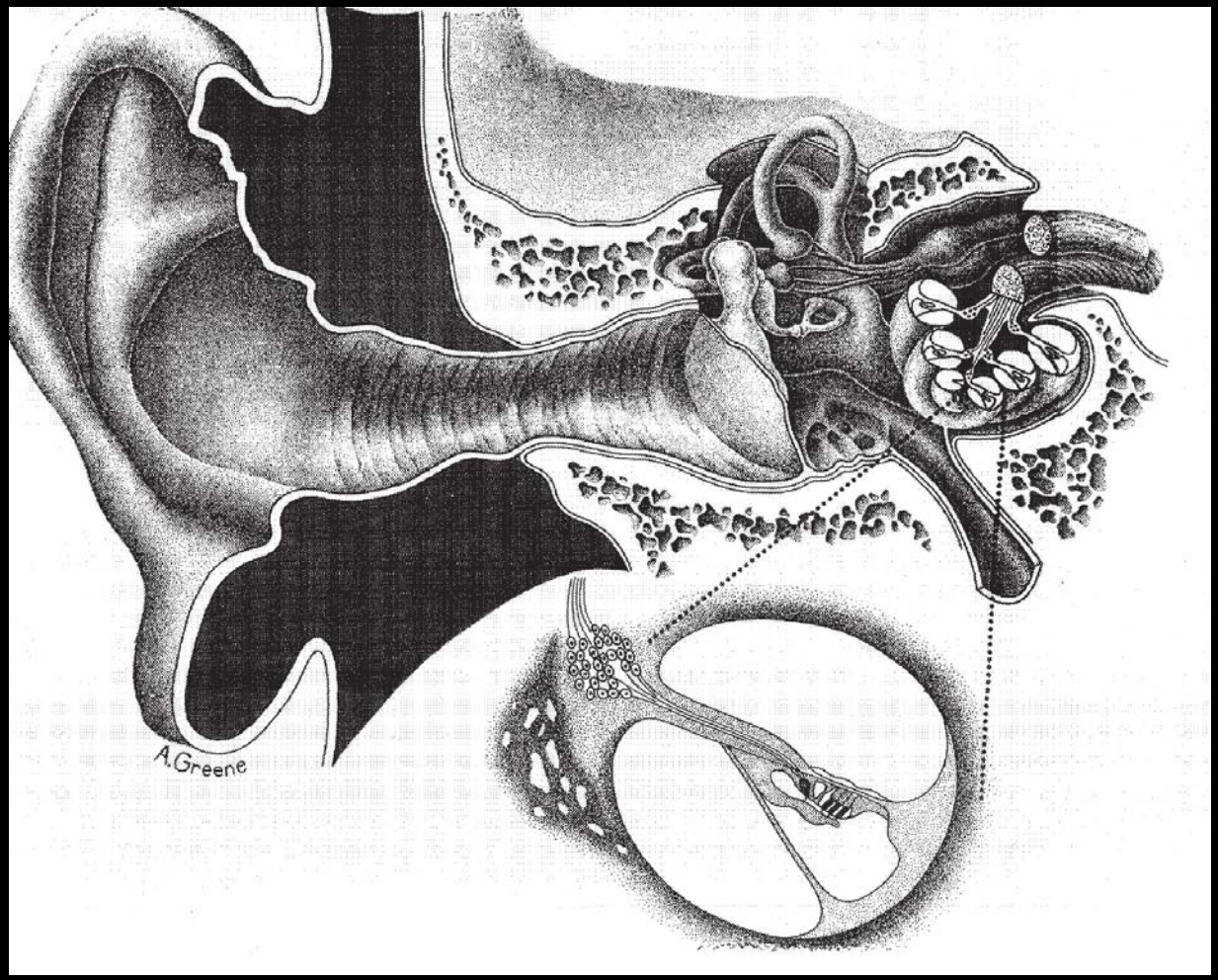
HST 721 Lecture 12:
Sensorineural Hearing Loss



SNHL: Perceptual Correlates

DEPARTMENT OF PHYSIOLOGY, HARVARD MEDICAL SCHOOL BOSTON, MASS.

CONTRACT OEMCMR-194

COMMITTEE ON MEDICAL RESEARCH OF THE OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT

FINAL REPORT ON

TEMPORARY DEAFNESS FOLLOWING EXPOSURE TO LOUD TONES AND NOISE

SEPTEMBER 30, 1943

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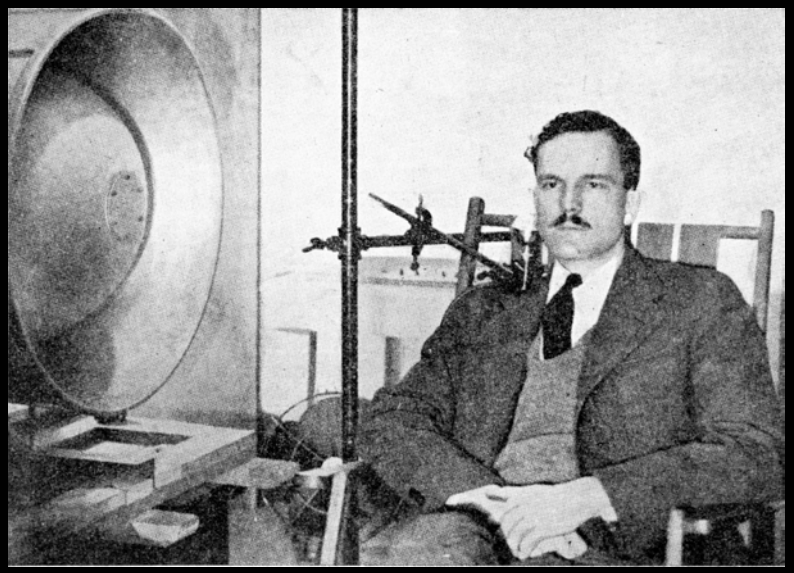

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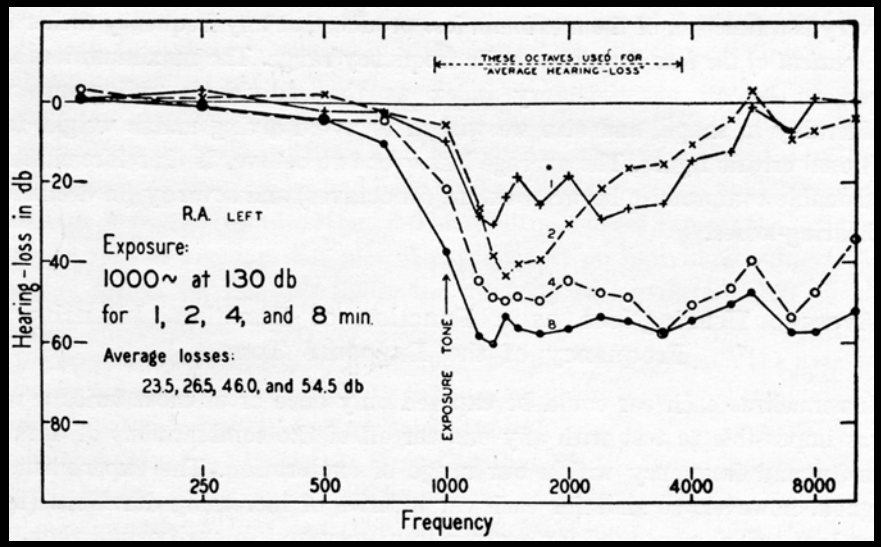
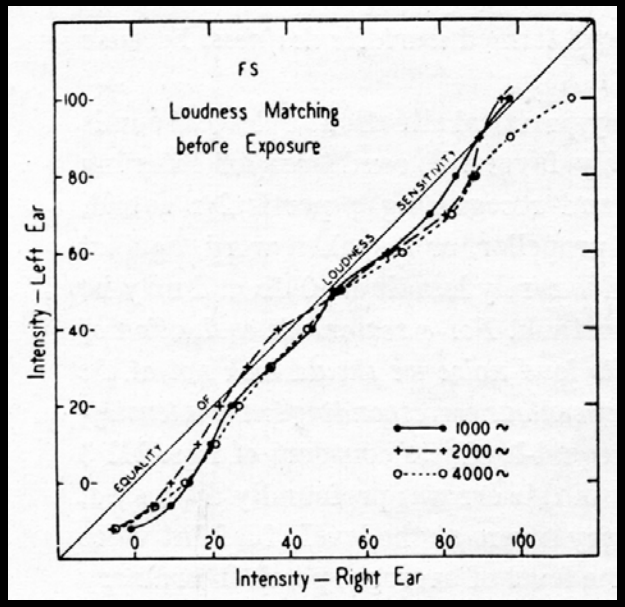
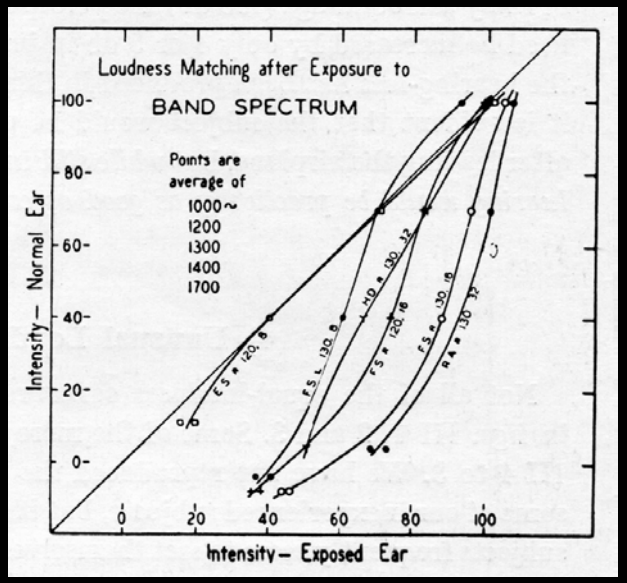


1. Threshold shifts

2. Problems in Noisy Environments

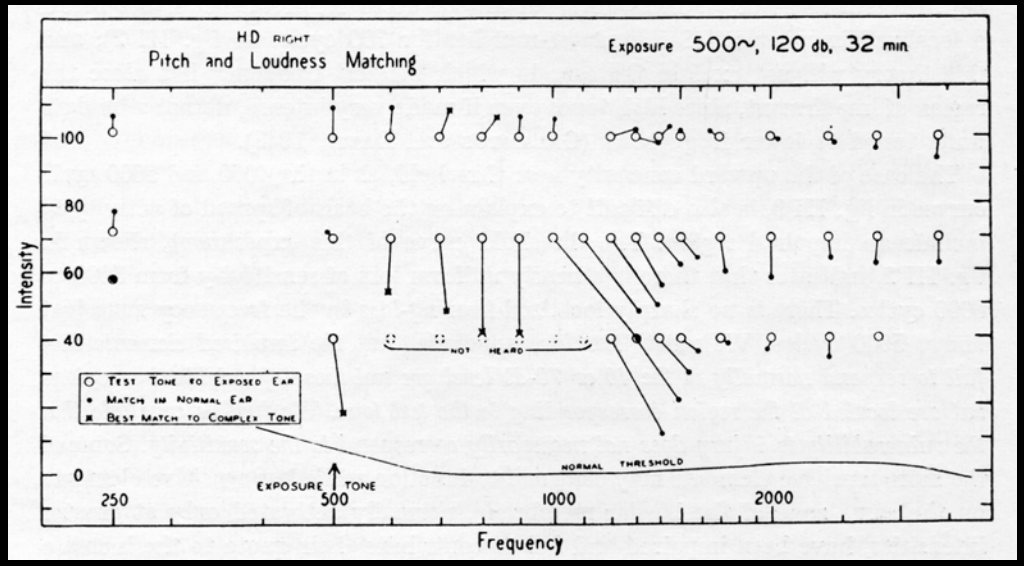


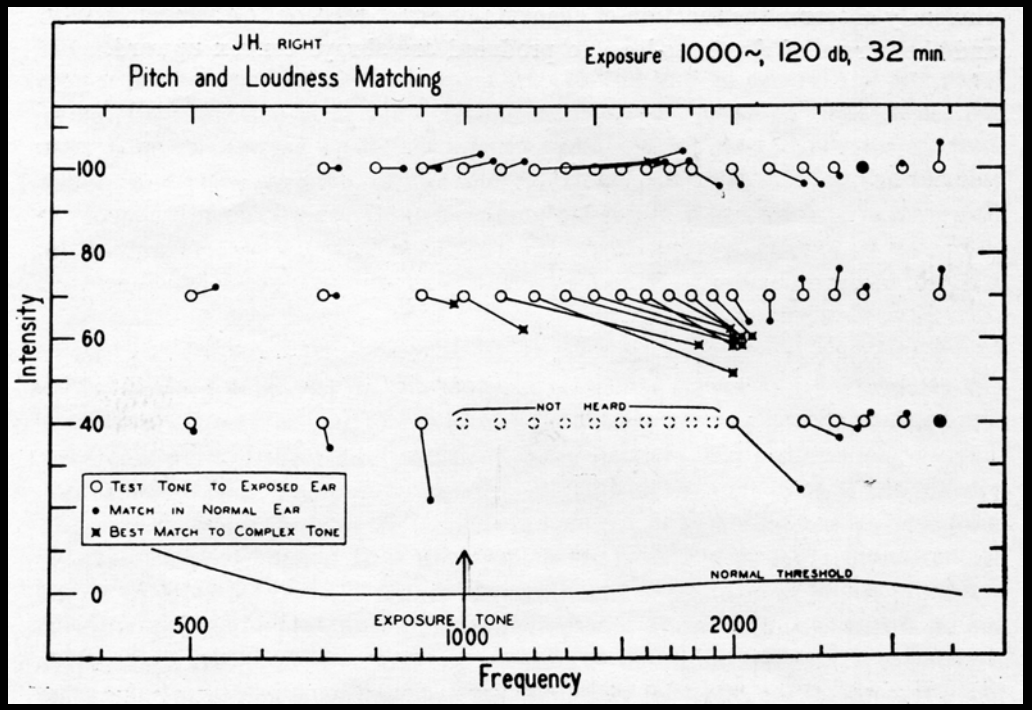


3. Loudness Recruitment

SNHL: Perceptual Correlates

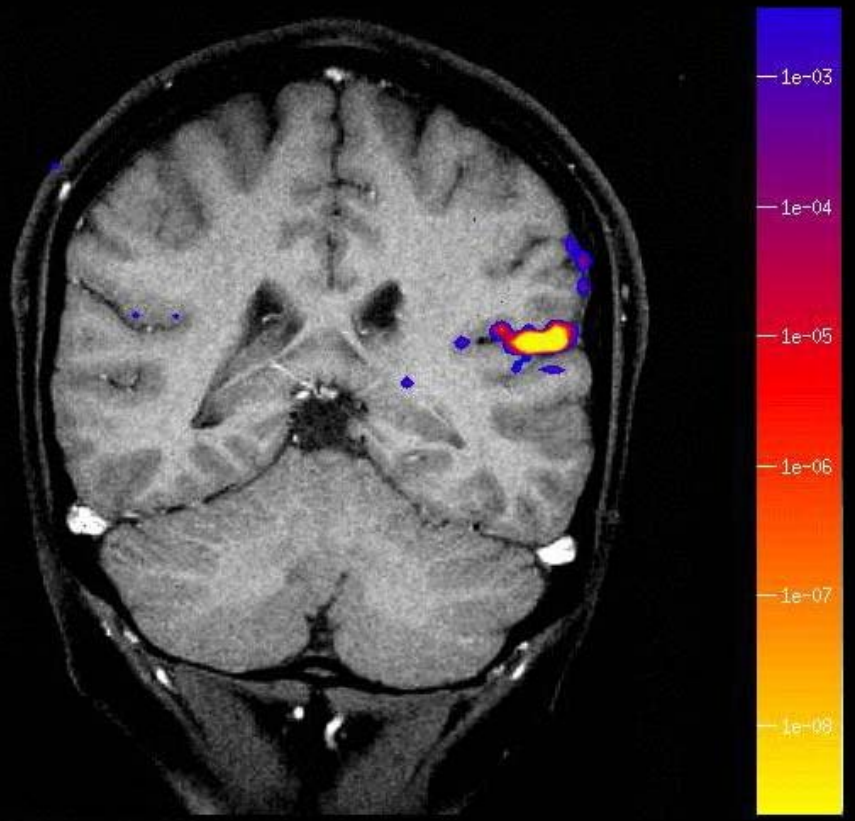
4. Pitch anomalies





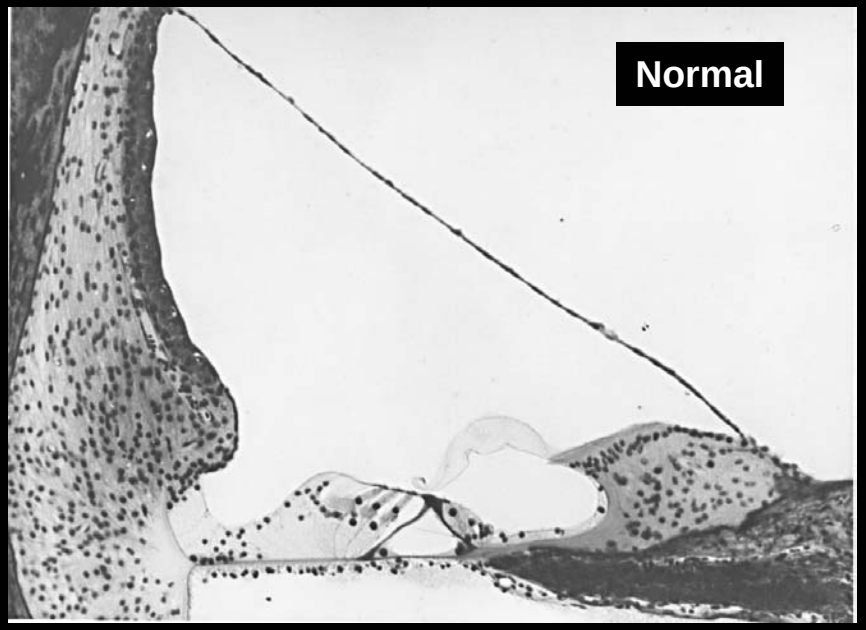
SNHL: Perceptual Correlates

5. Tinnitus



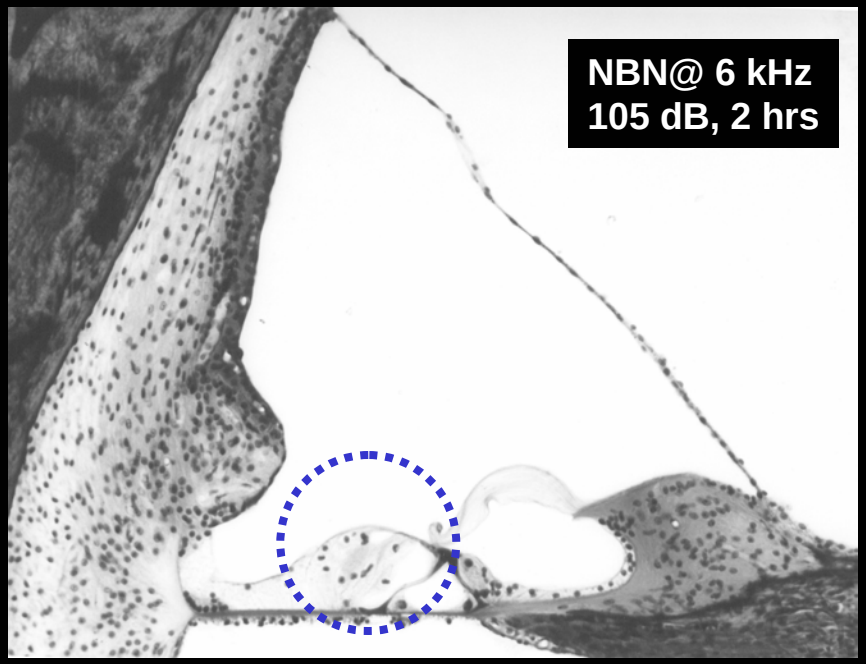
Courtesy of
Jennnifer R. Melcher Ph.D.
Harvard Medical School

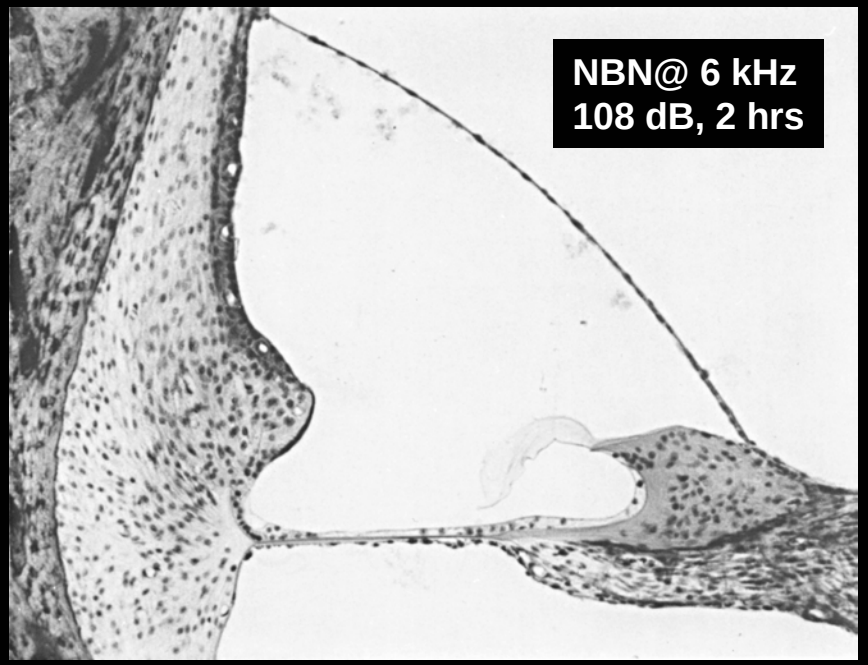
SNHL: Histopathology



Hair cells and supporting cells particularly vulnerable.

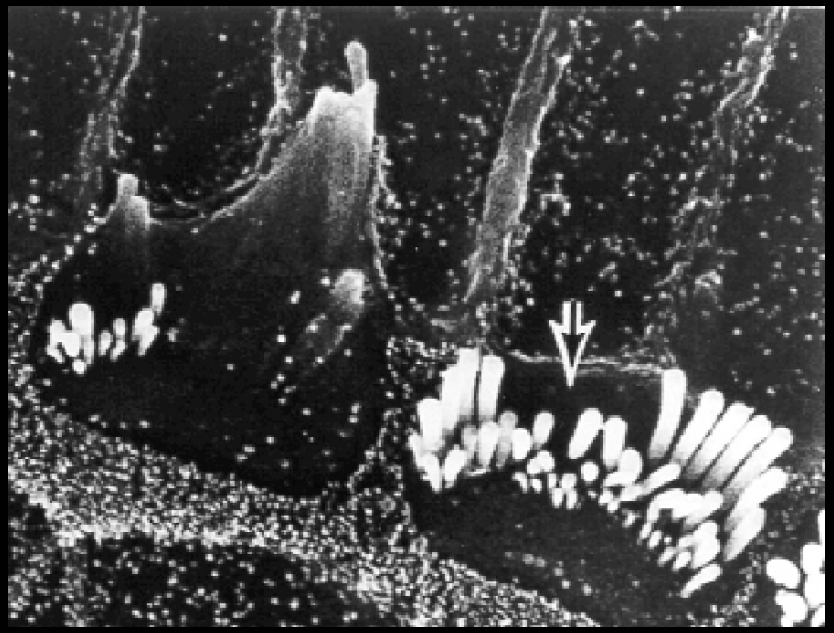
OHCs most vulnerable



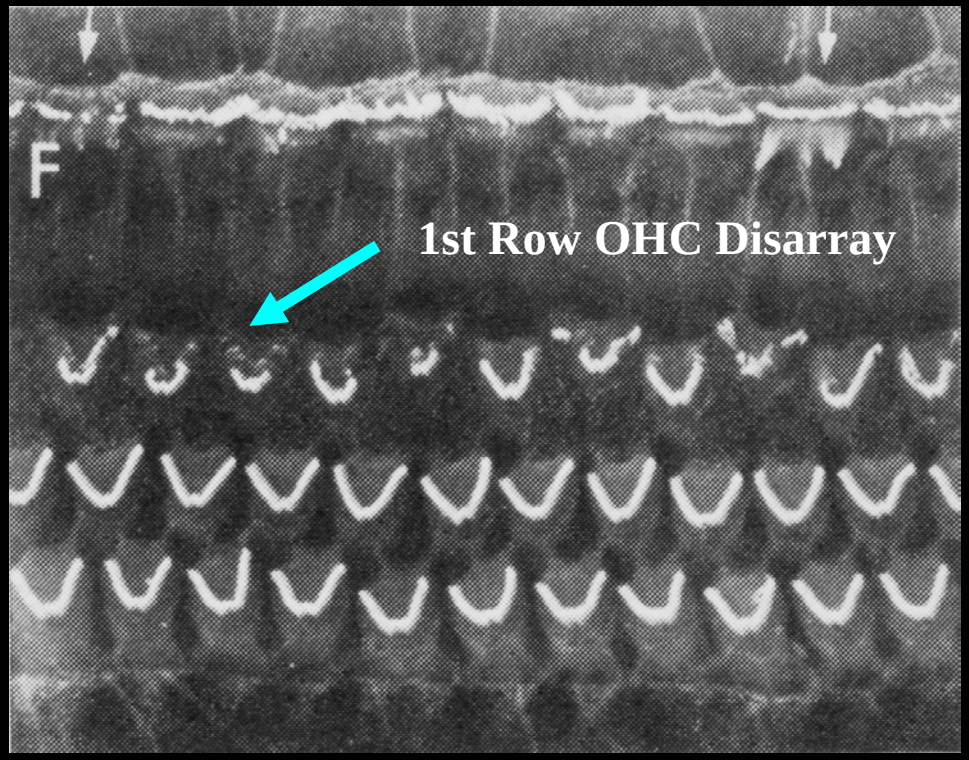


Acoustic trauma in cats

SNHL: Histopathology



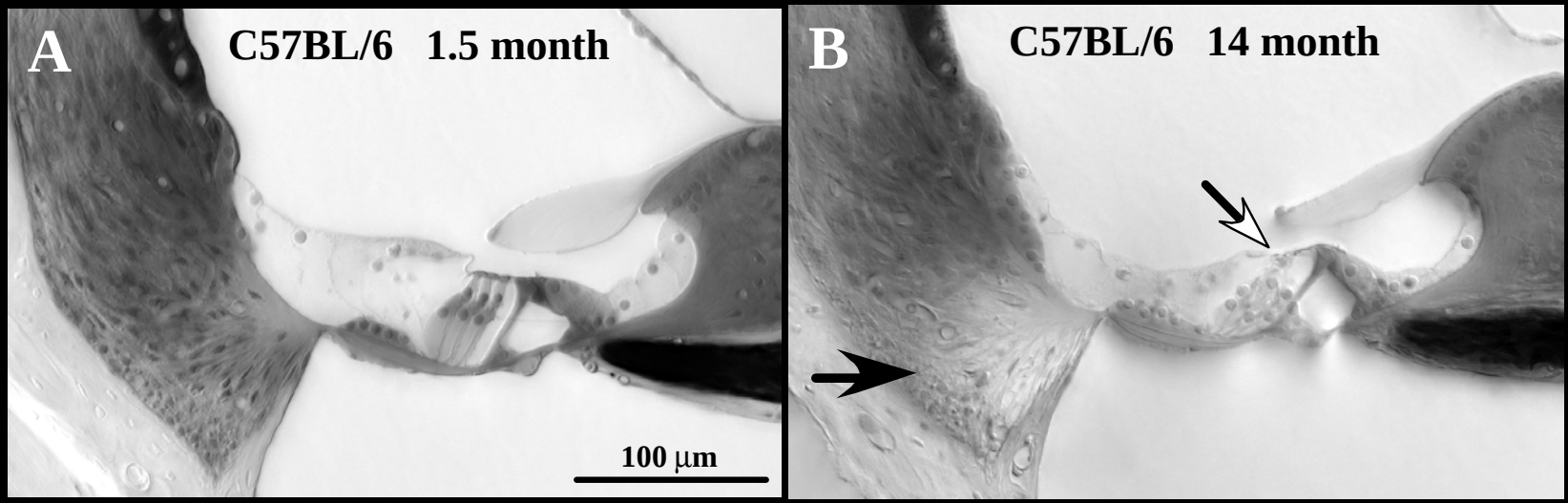
Stereocilia damage on
remaining IHCs and OHCs



Acoustic trauma in cats and guinea pigs

SNHL: Histopathology

Spiral ligament fibrocytes can also be involved

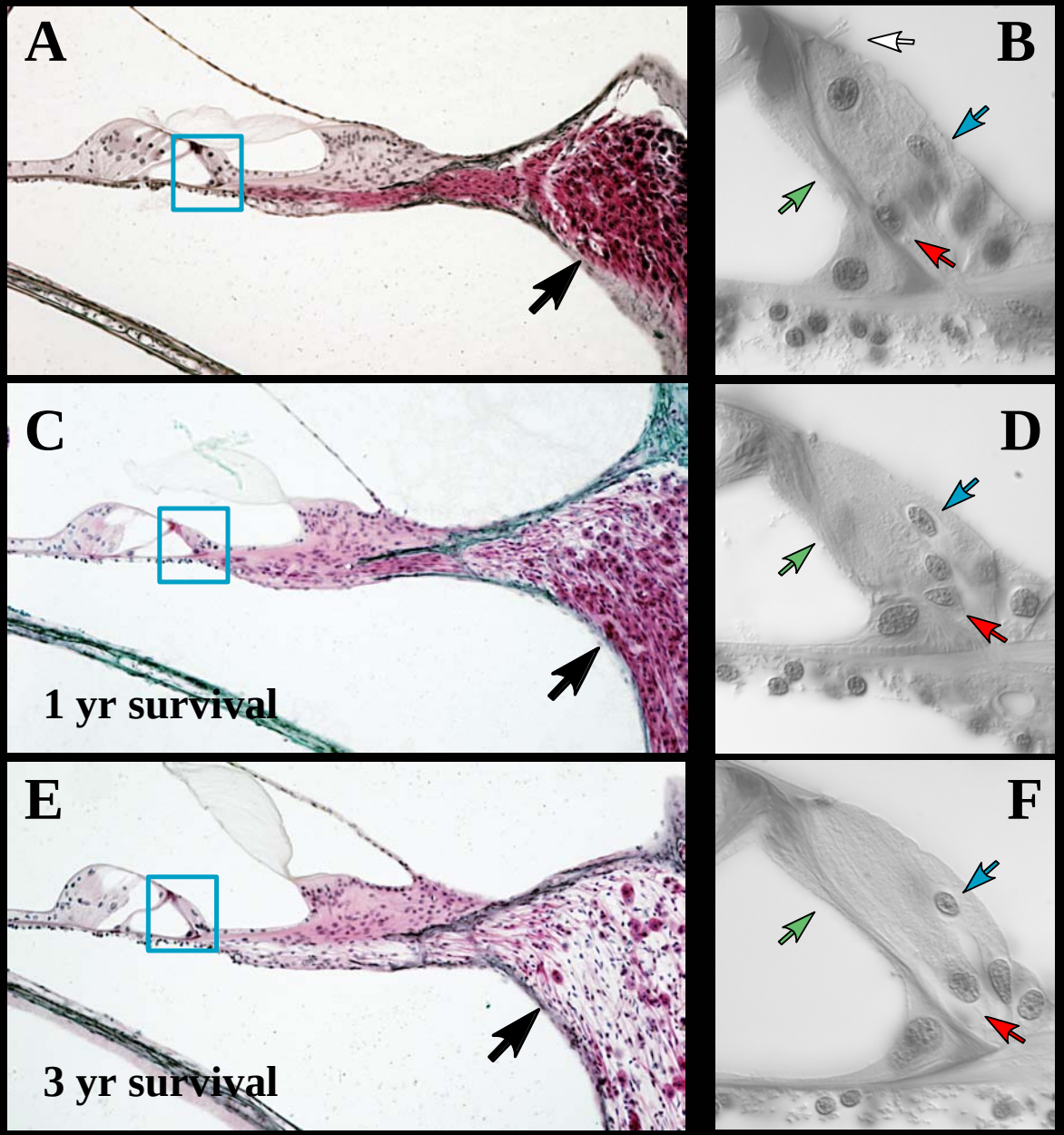


Aging in the C57BL/6 mouse

SNHL: Histopathology

Nerve loss is usually secondary to IHC loss

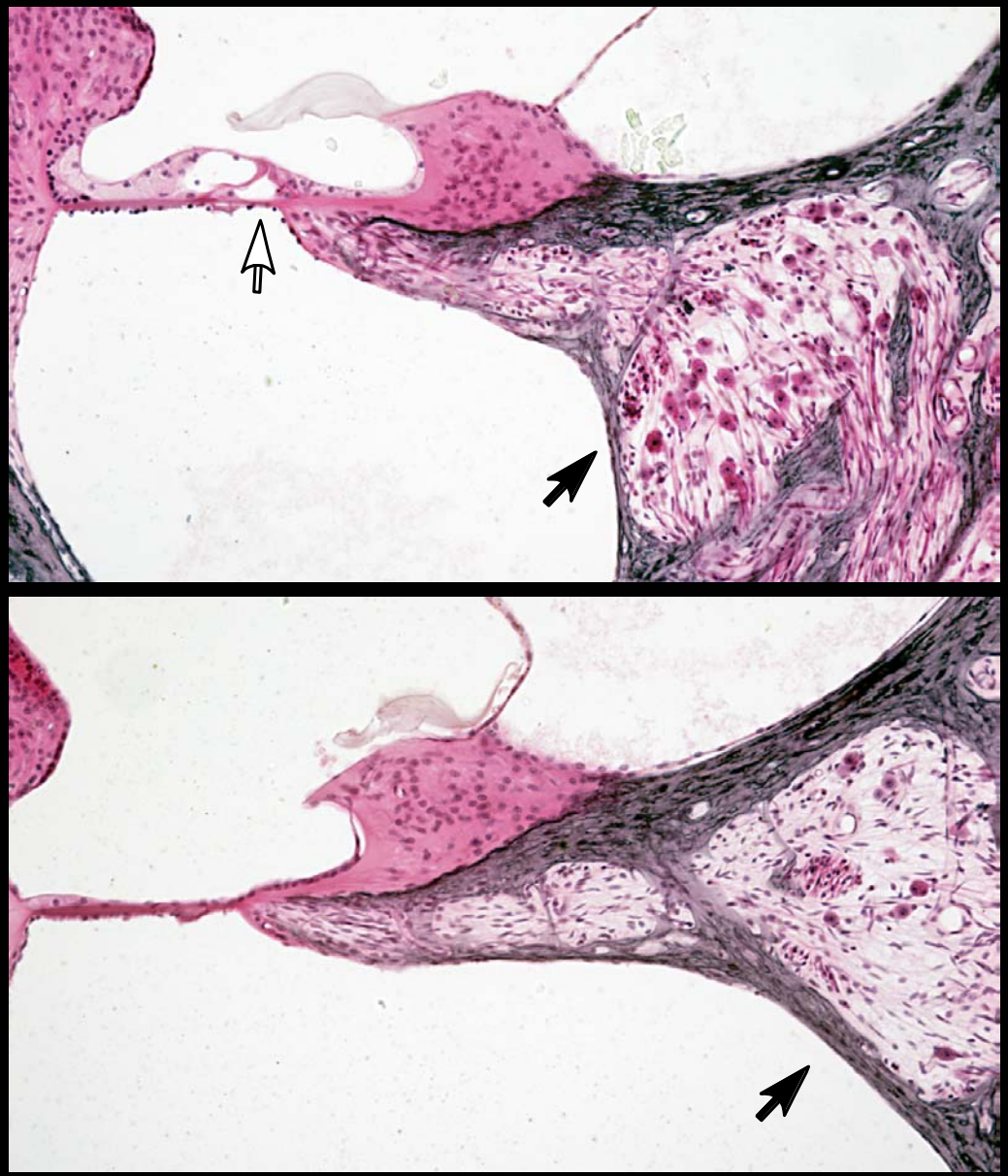
Can progress for years after injury



Kanamycin-treated cats

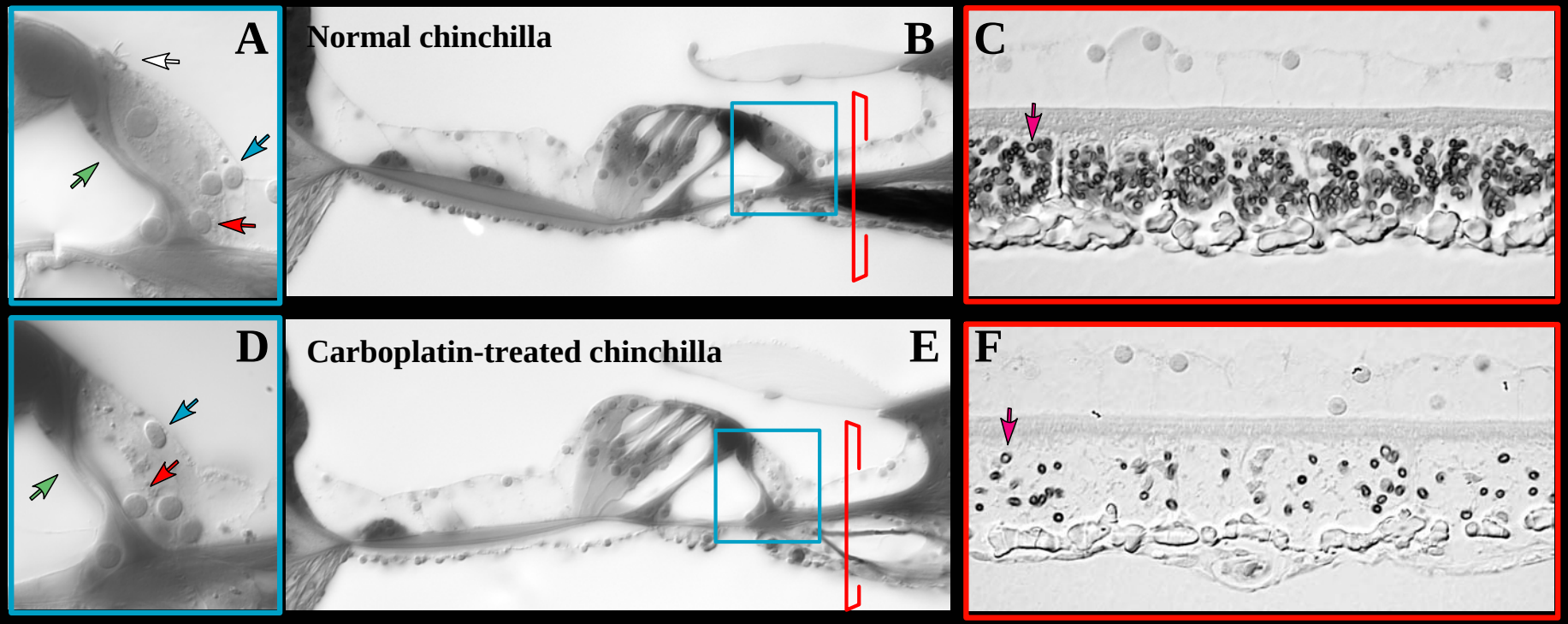
SNHL: Histopathology

Nerve fiber loss is more complete when both IHCs and supporting cells degenerate



Kanamycin-treated cats

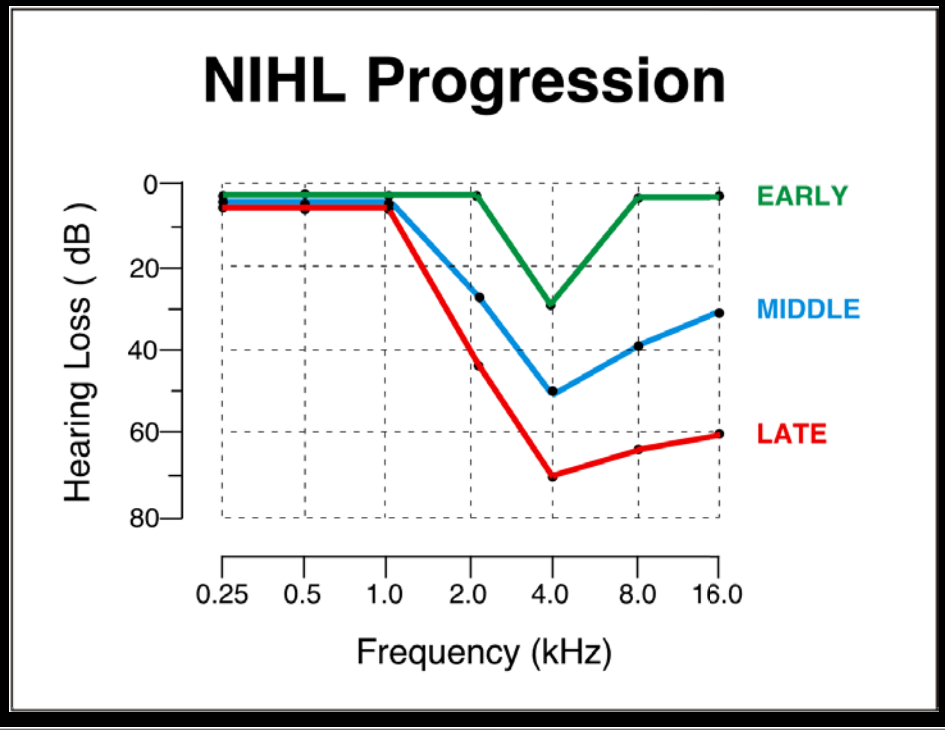
SNHL: Histopathology

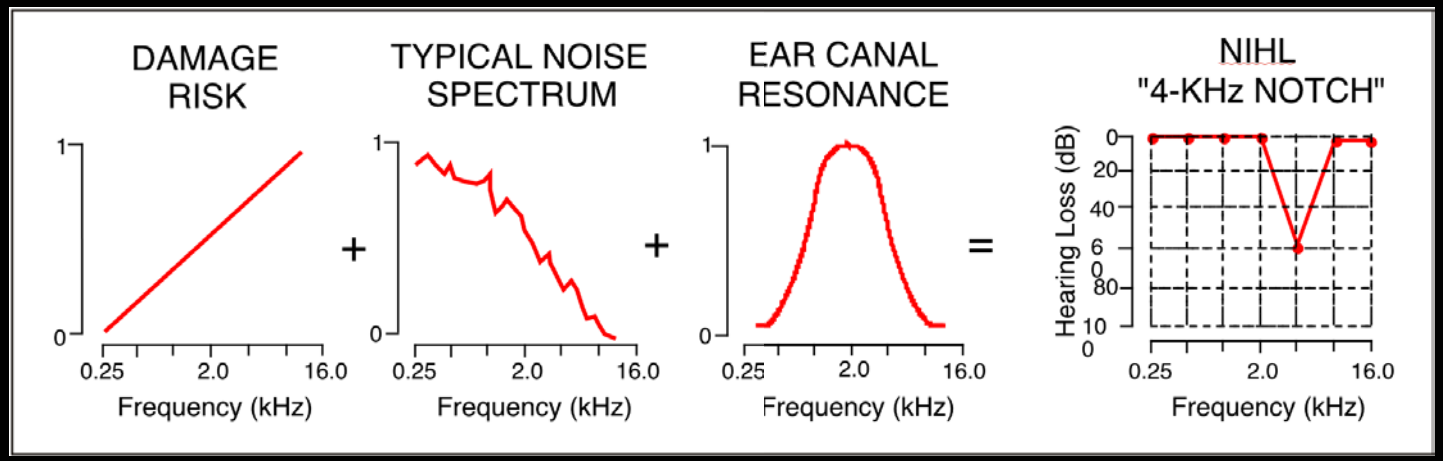


Selective IHC loss is extremely rare

SNHL: Basal-apical gradient

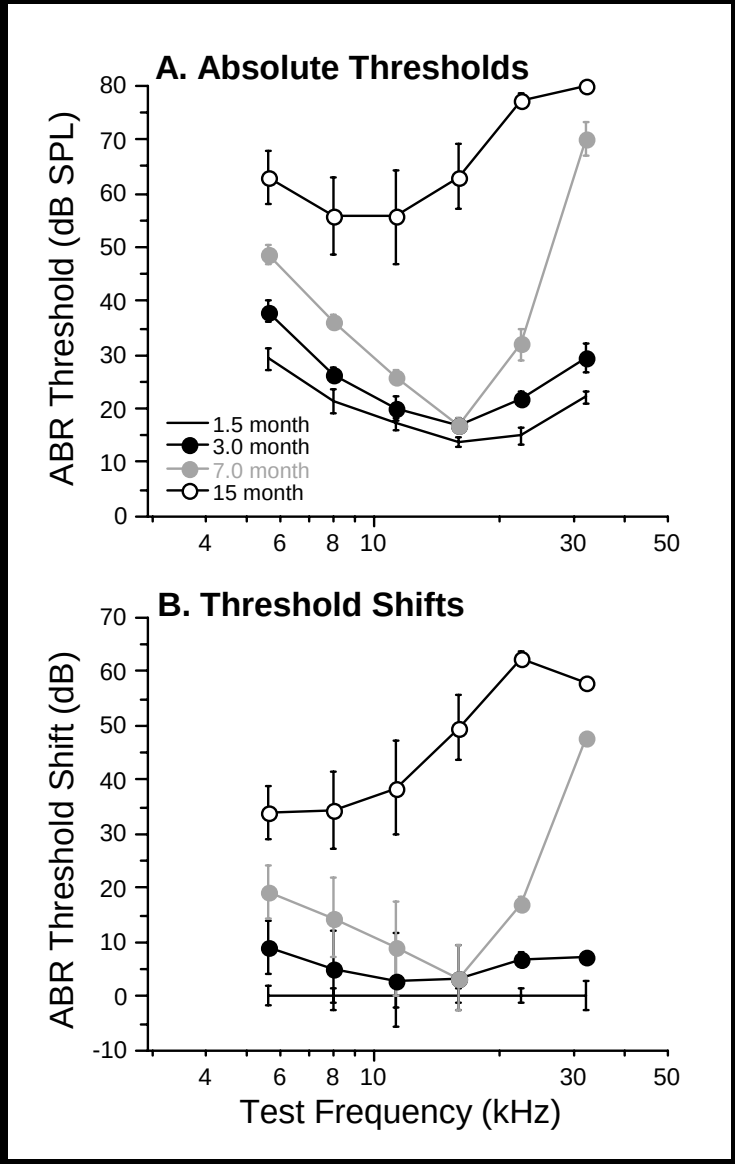
Human: Workplace Exposures

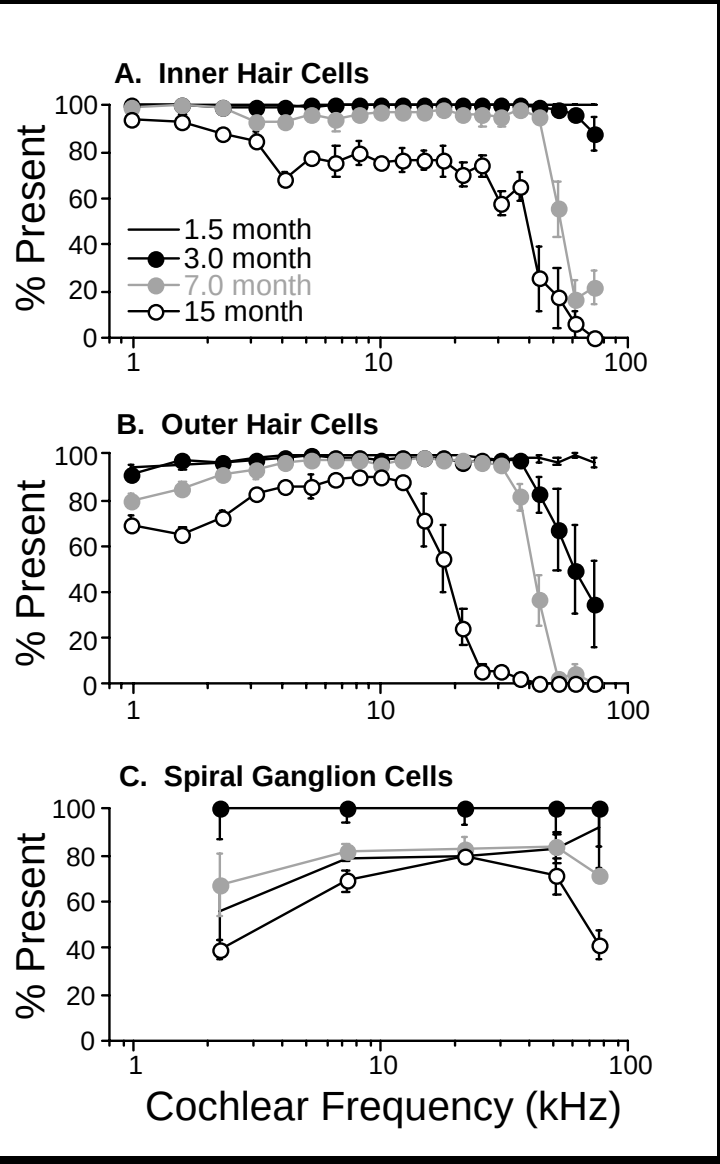




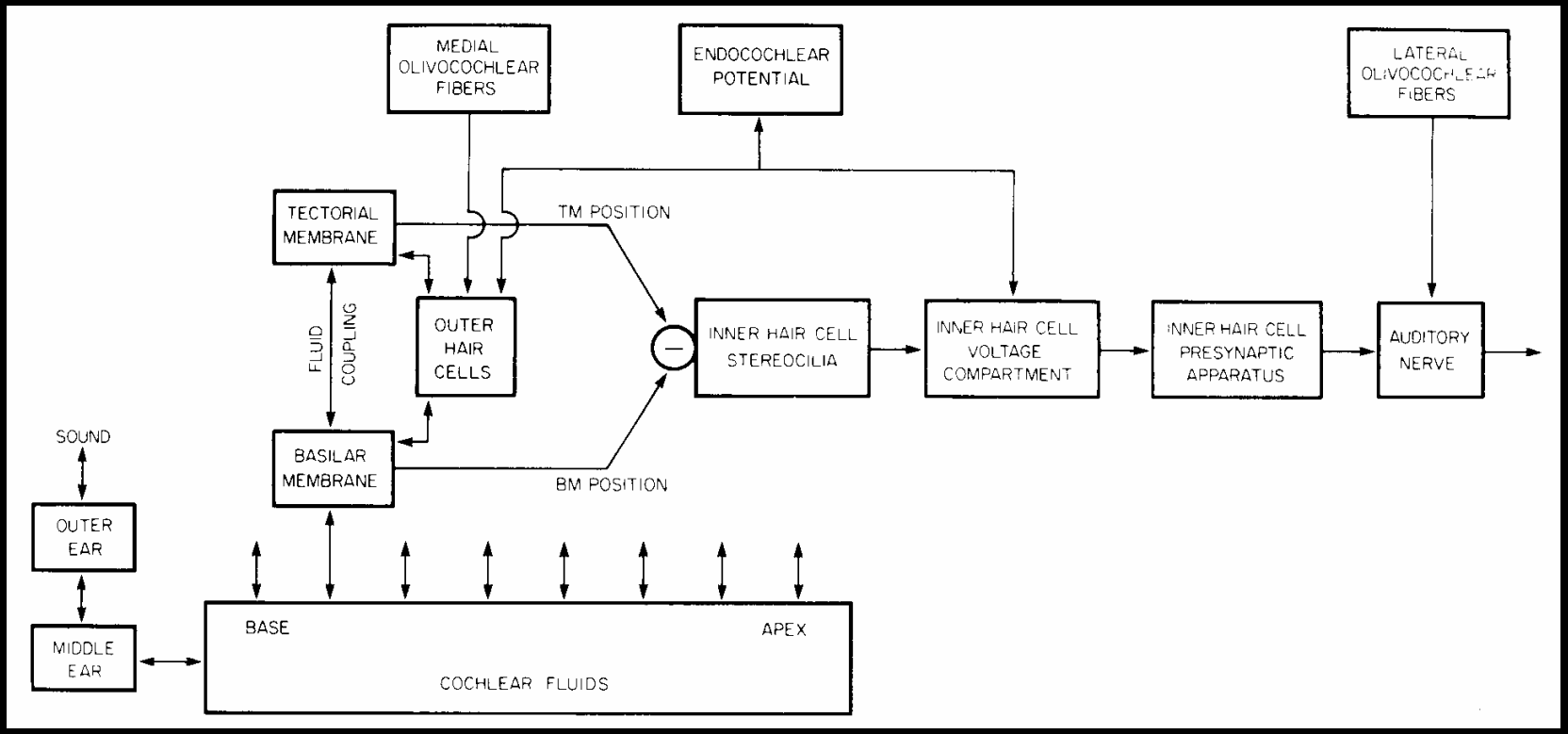
SNHL: Basal-apical gradient

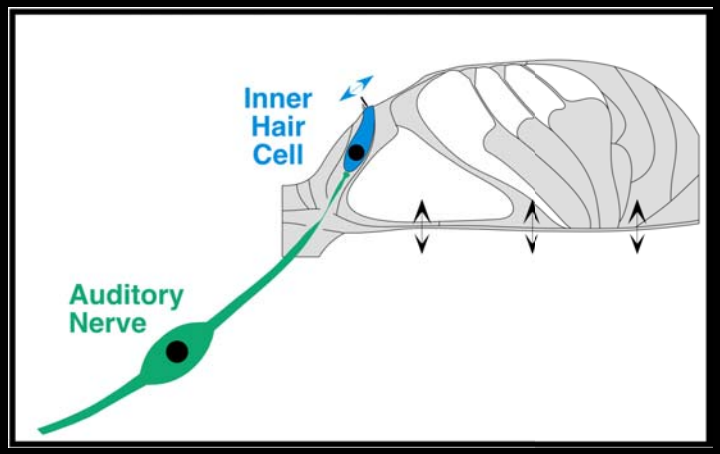
Mouse: Aging in the C57BL/6 strain

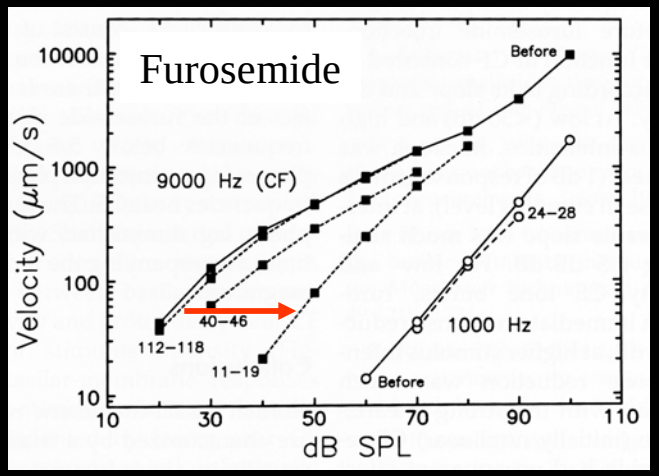




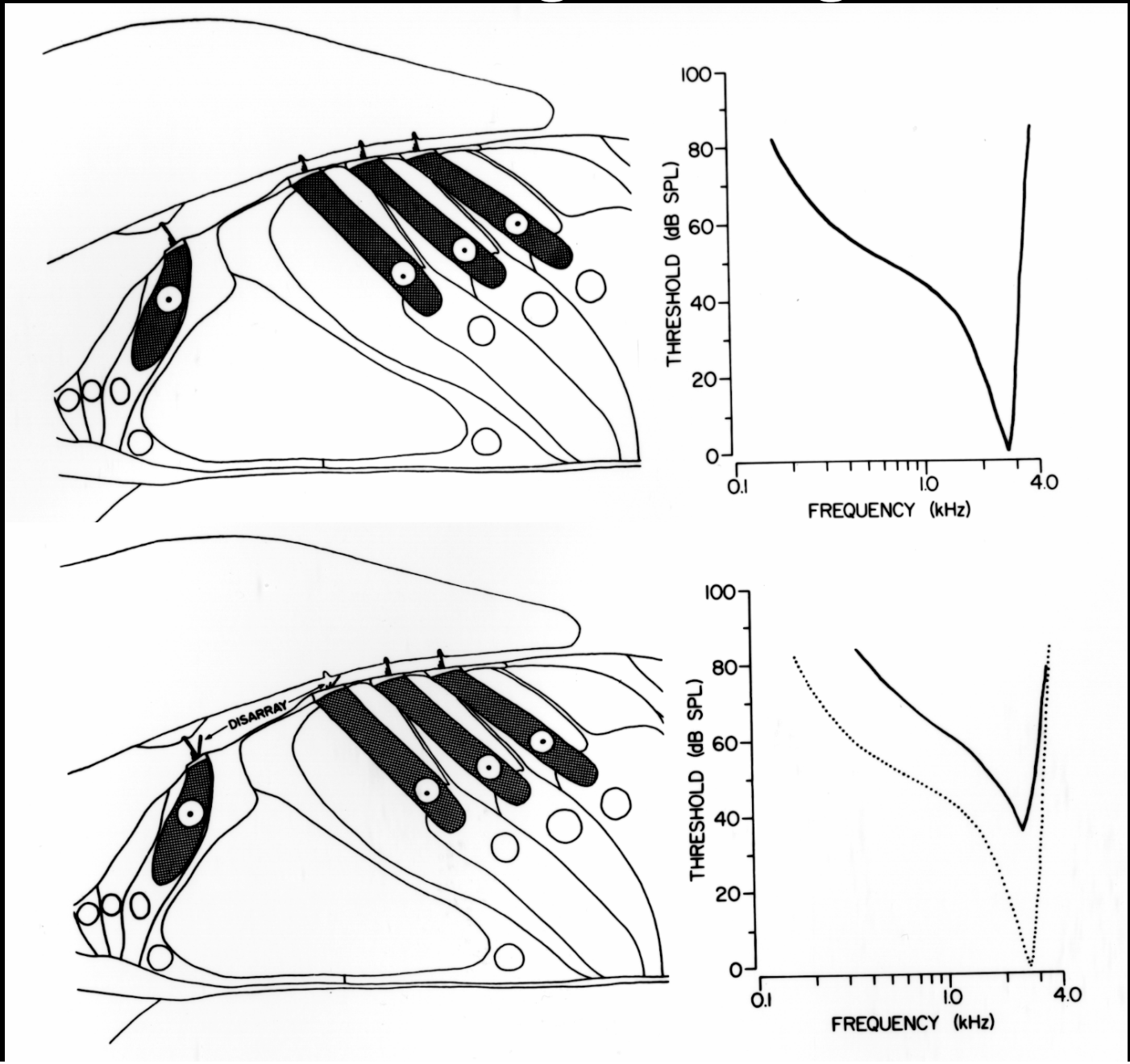
Effects of OHC loss: tuning and threshold



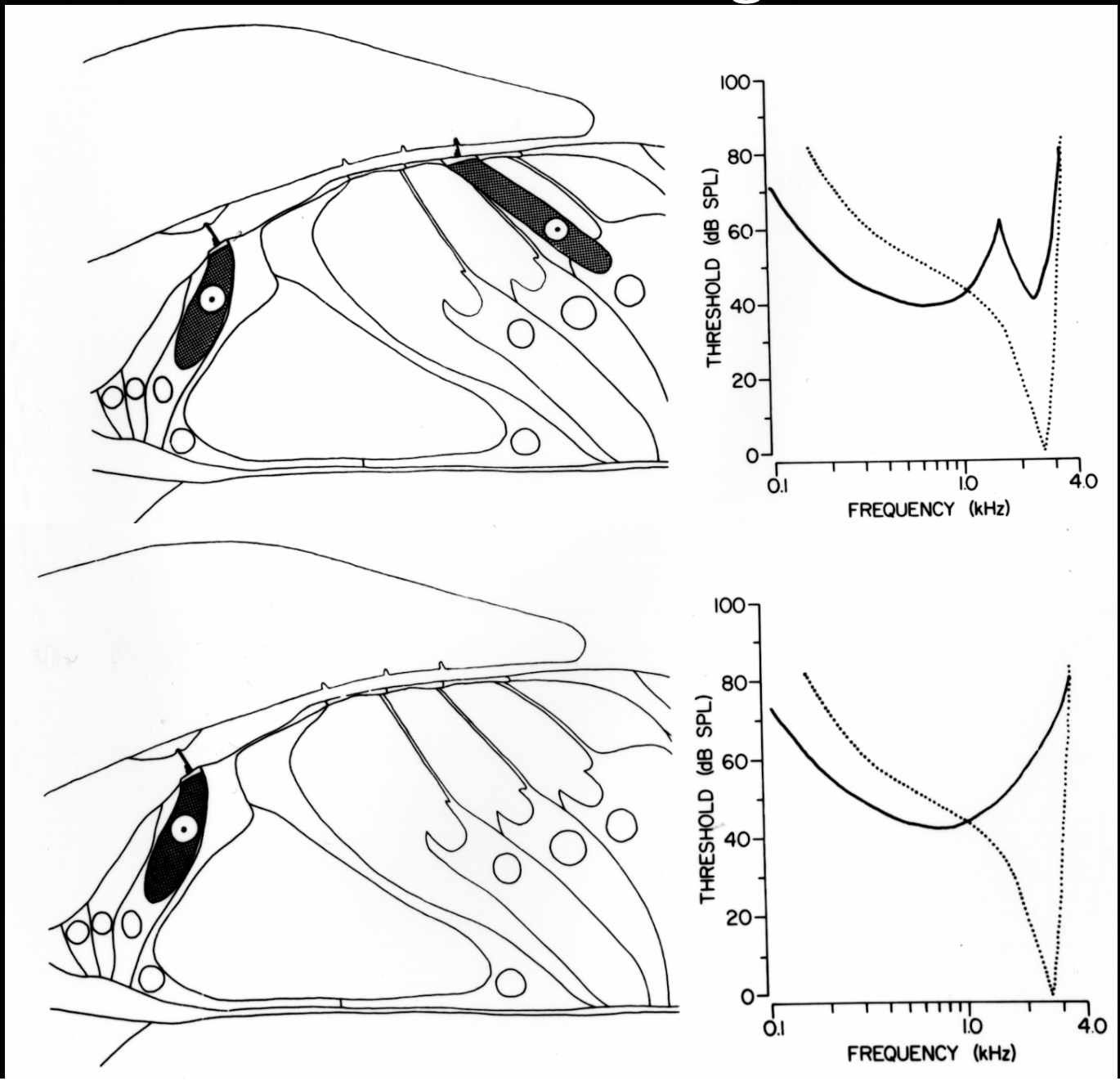




Effects of IHC damage: tuning and threshold



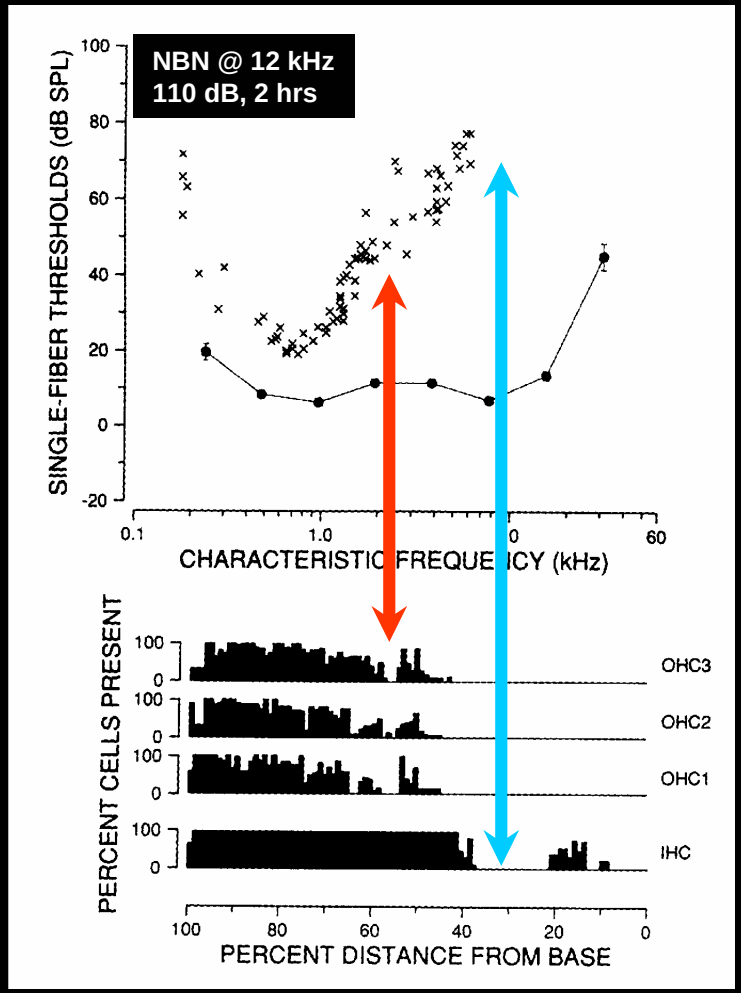
Effects of OHC loss: tuning and threshold



Effects of HC loss: tuning and threshold

Auditory Nerve Thresholds

Hair Cell Loss Patterns



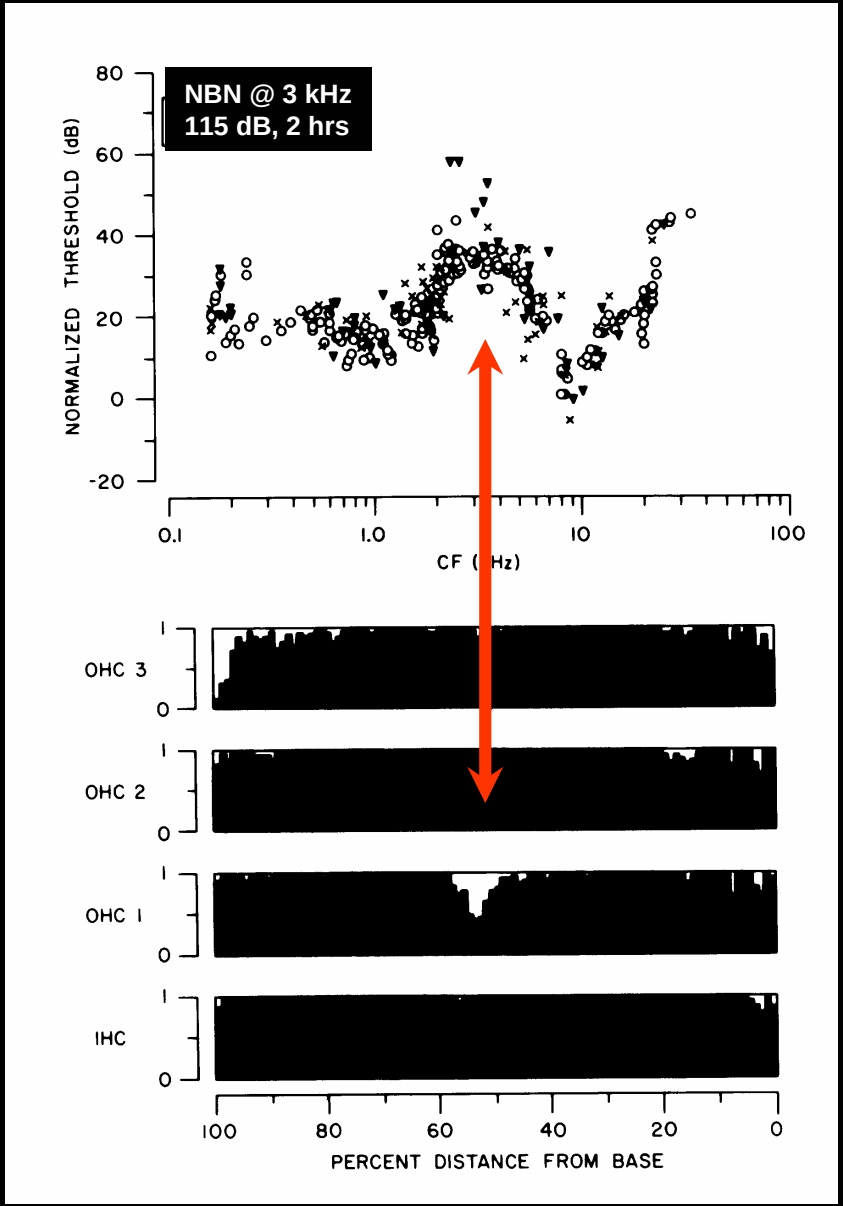
OHC loss raises thresholds

IHC loss makes non-responsive regions

Effects of OHC loss: tuning and threshold

Auditory Nerve Thresholds

Hair Cell Loss Patterns

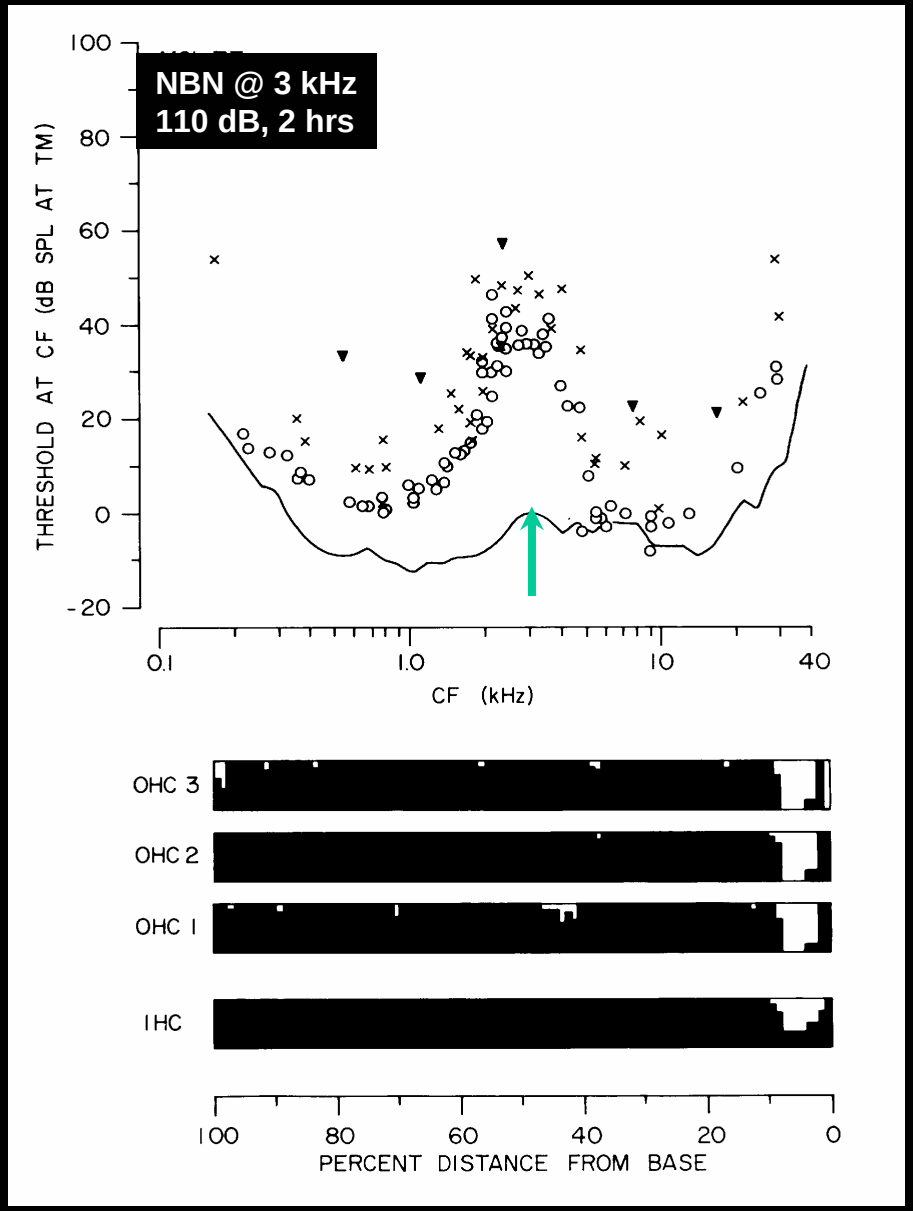


OHC loss raises thresholds

Stereocilia damage: tuning and threshold

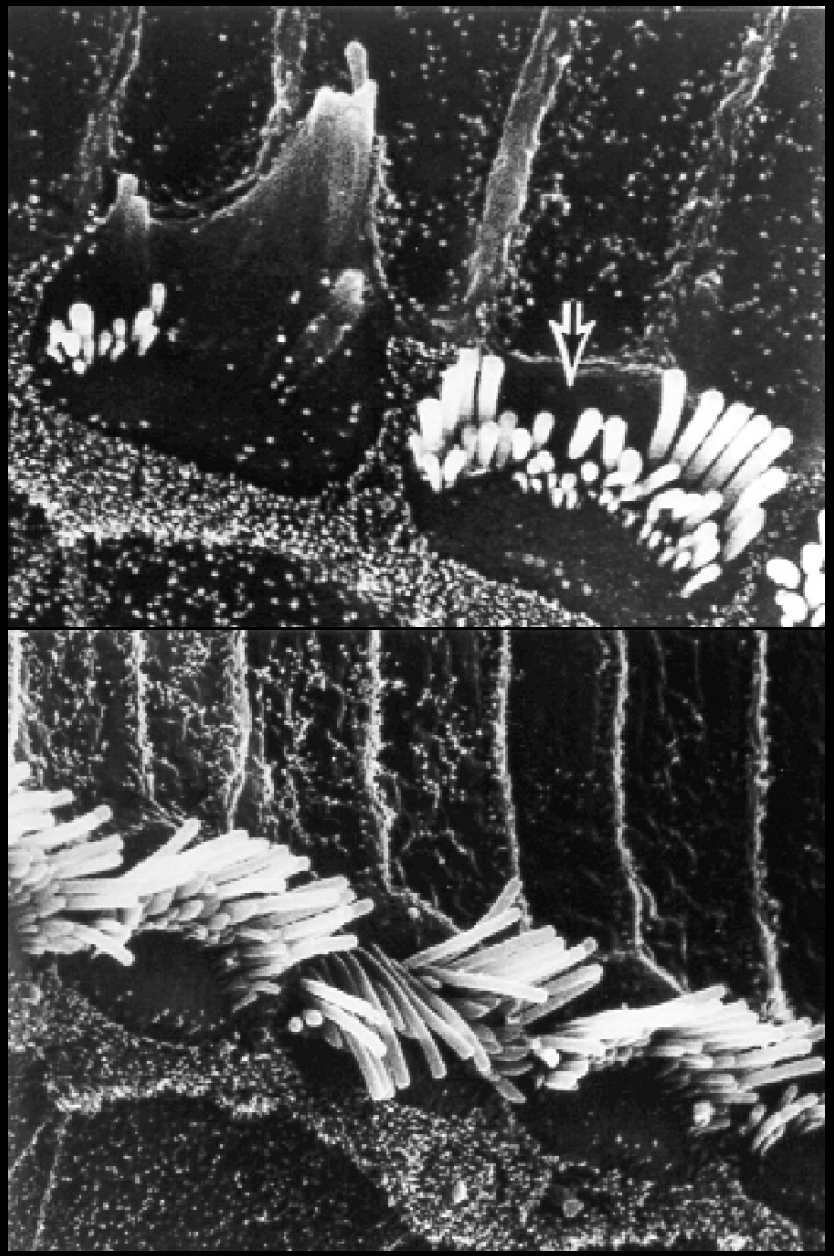
Auditory Nerve Thresholds

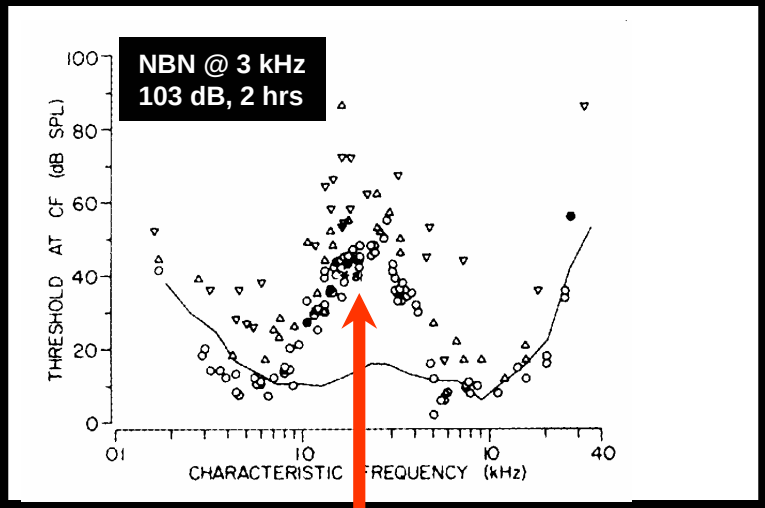
Hair Cell Loss Patterns

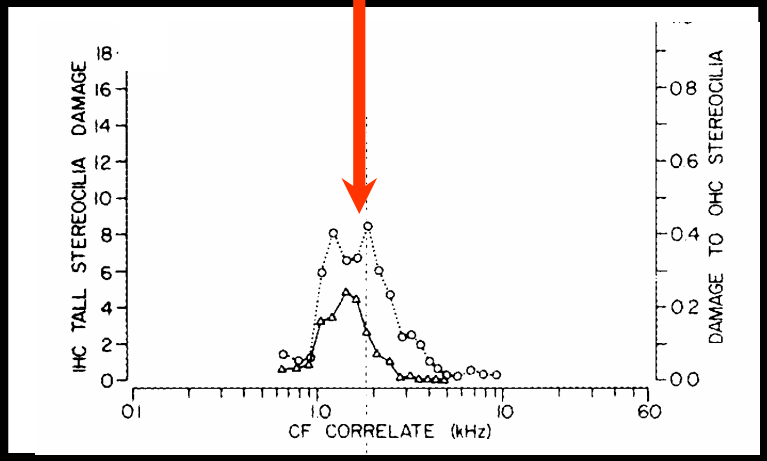


Note damage focus in extreme base

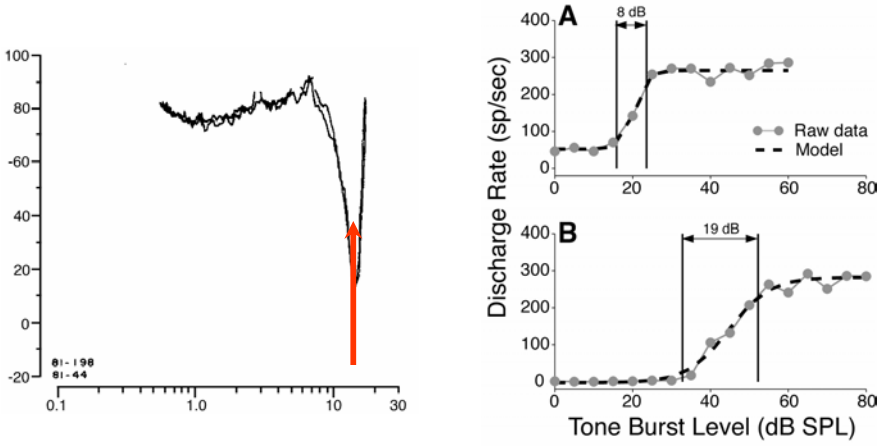
Stereocilia damage: tuning and threshold





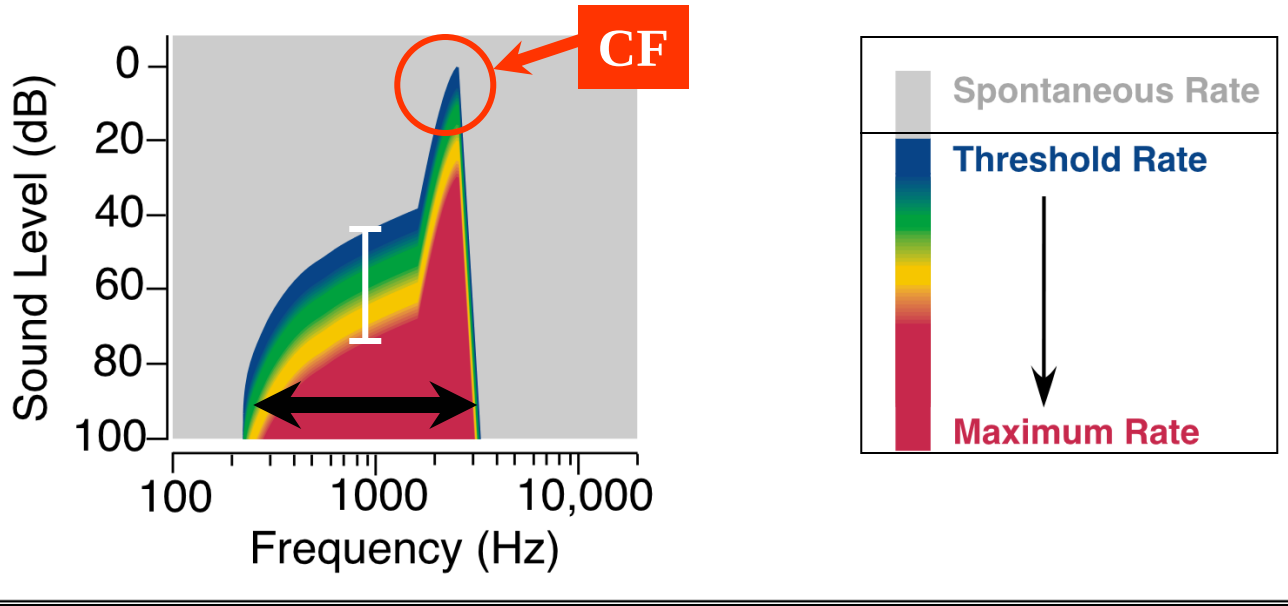


OHC loss: SR and dynamic range

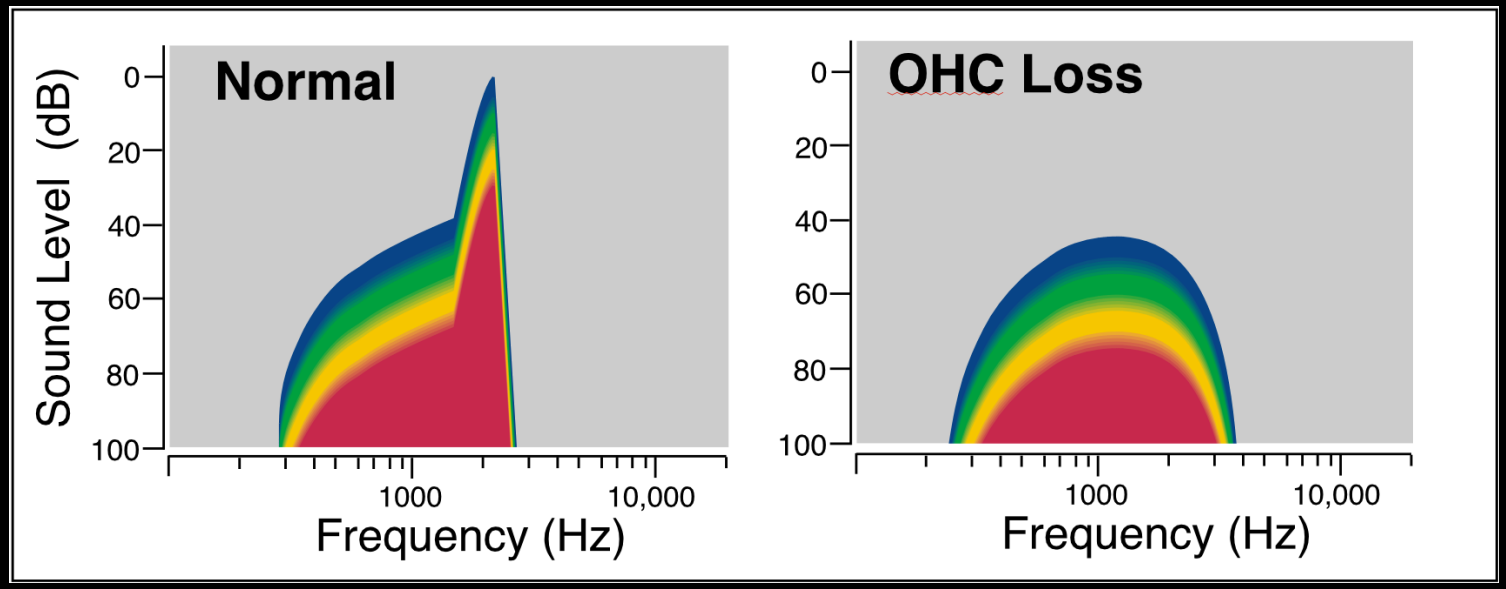


Dynamic range = SPLs over which discharge rate increases

Normal Ear
dynamic range ~ 30 dB



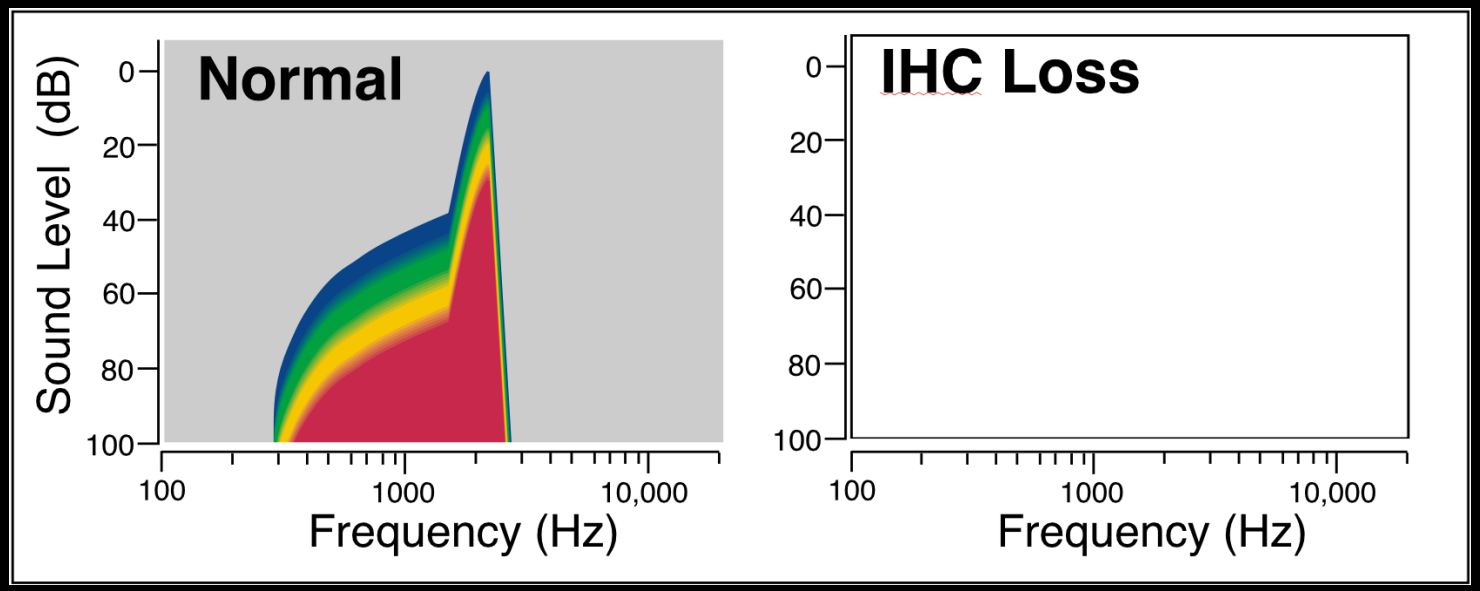
OHC loss: SR and dynamic range



After OHC loss, the neural response shows:

- **40 dB decrease in sensitivity & loss of sharp tuning**
- **No change in spontaneous discharge rate**
- **No change in maximum discharge rate**
- **No change in dynamic range**

IHC loss : SR and dynamic range

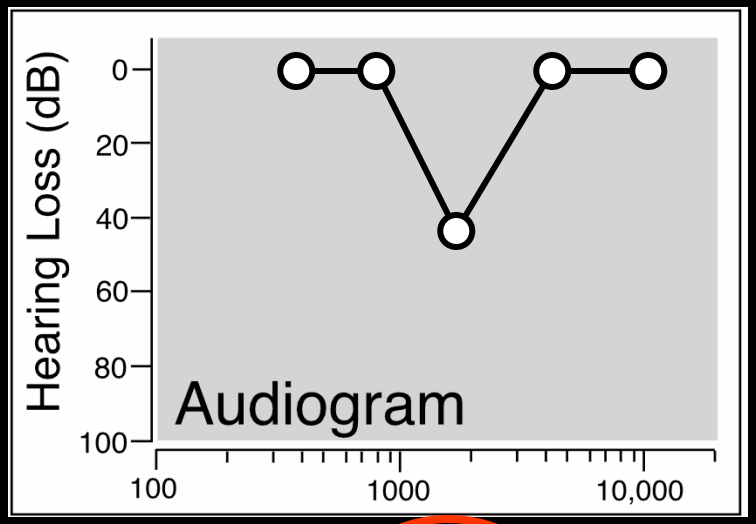


After IHC loss, the neural response area shows:

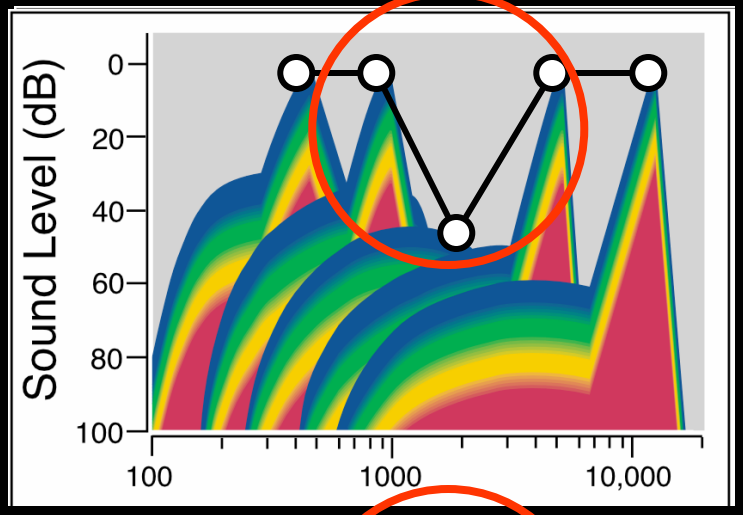
No response to sound

No spontaneous activity

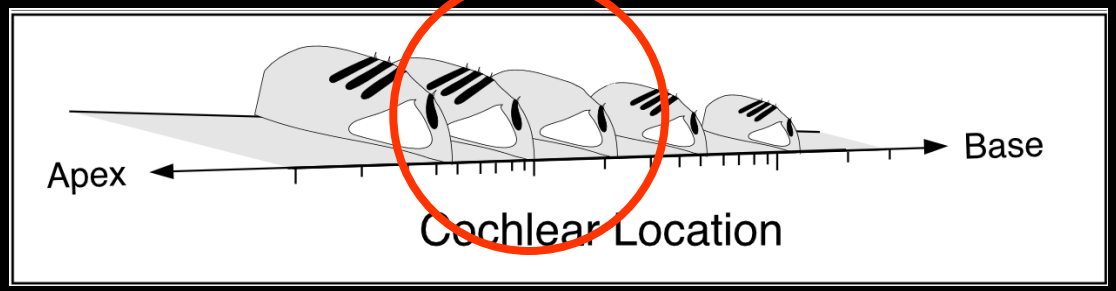
OHC loss and the Audiogram



Produces “notched” audiogram

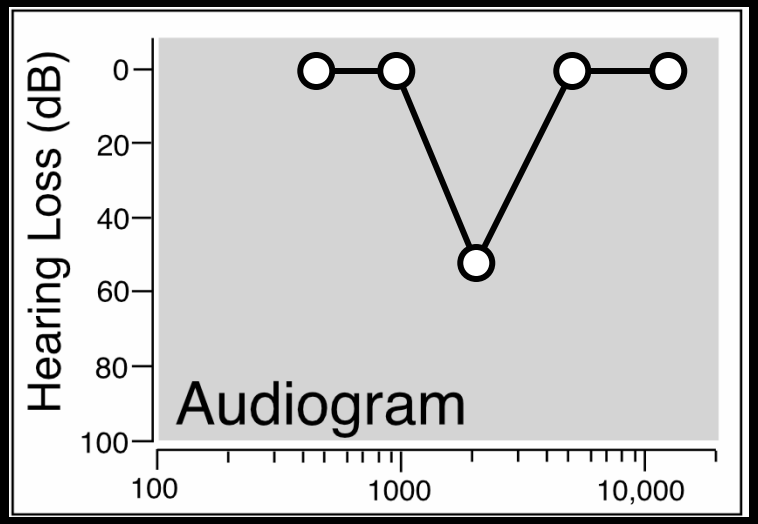


Response loss only for mid frequency

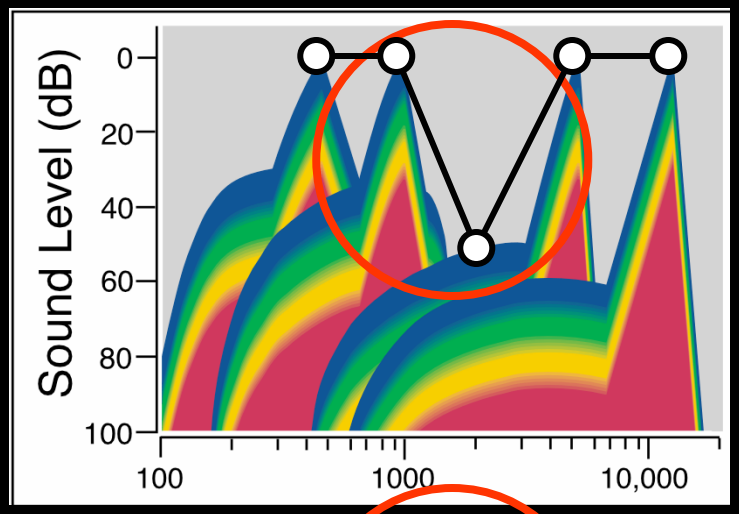


OHC loss restricted to middle of cochlea

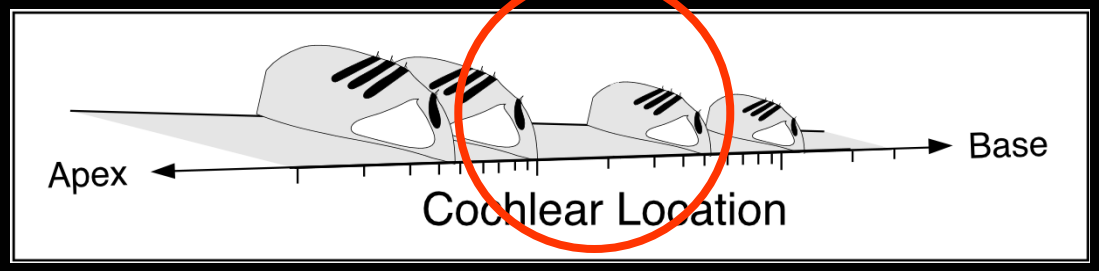
IHC loss and the Audiogram



Produces “notched” audiogram, as for OHC loss

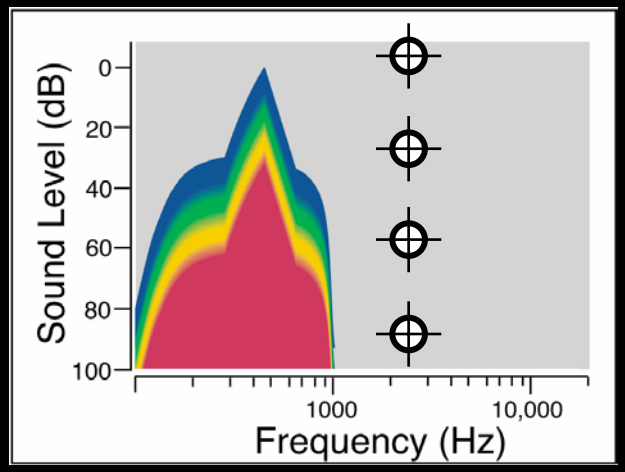


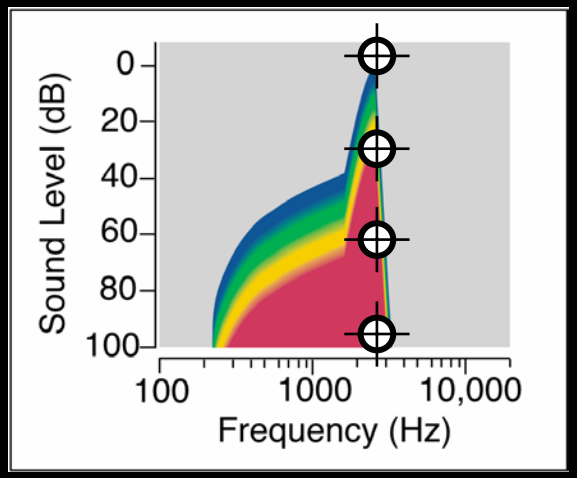
Response loss only for mid frequency

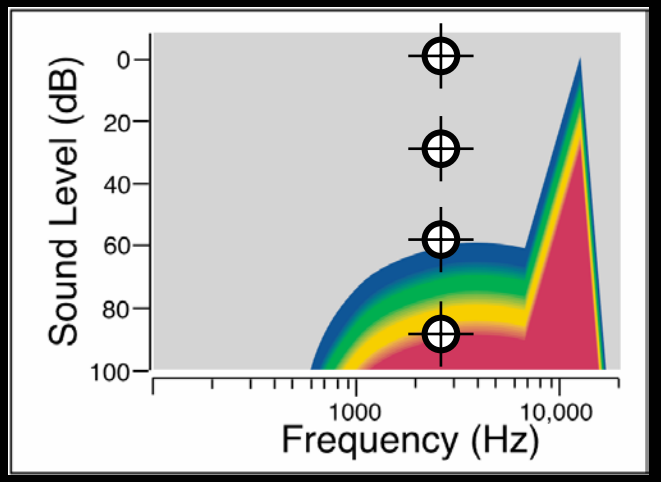


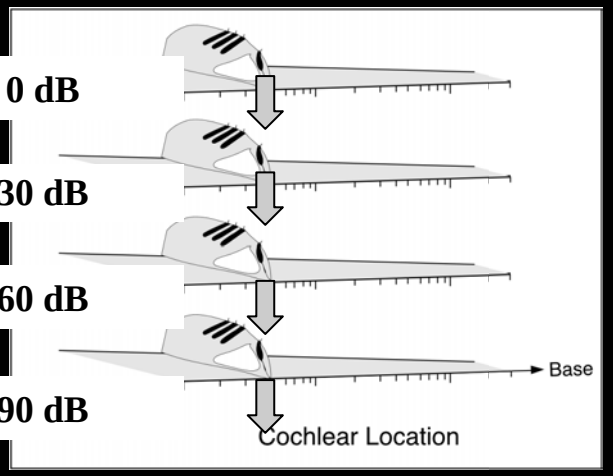
OHC & IHC loss restricted to middle of cochlea

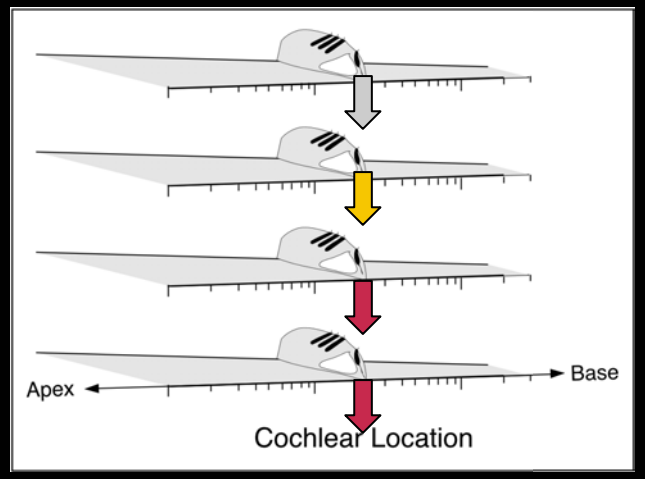
HC loss and loudness recruitment: Normal Ear

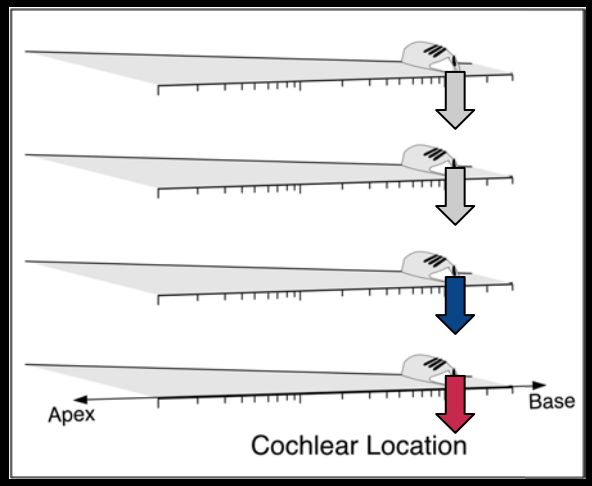




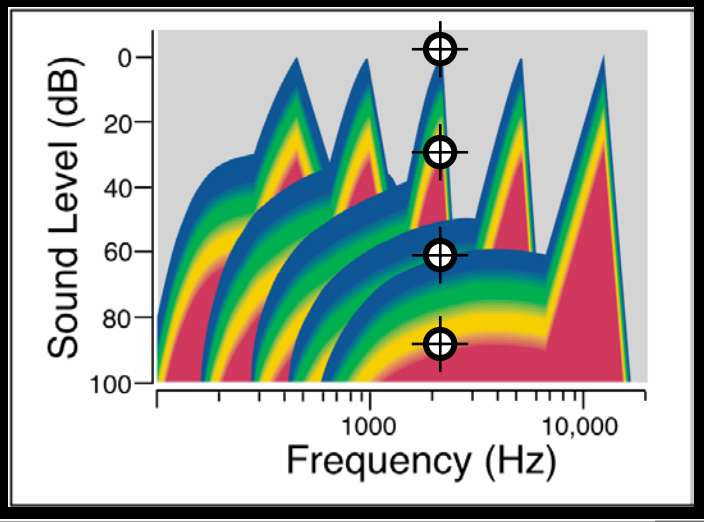


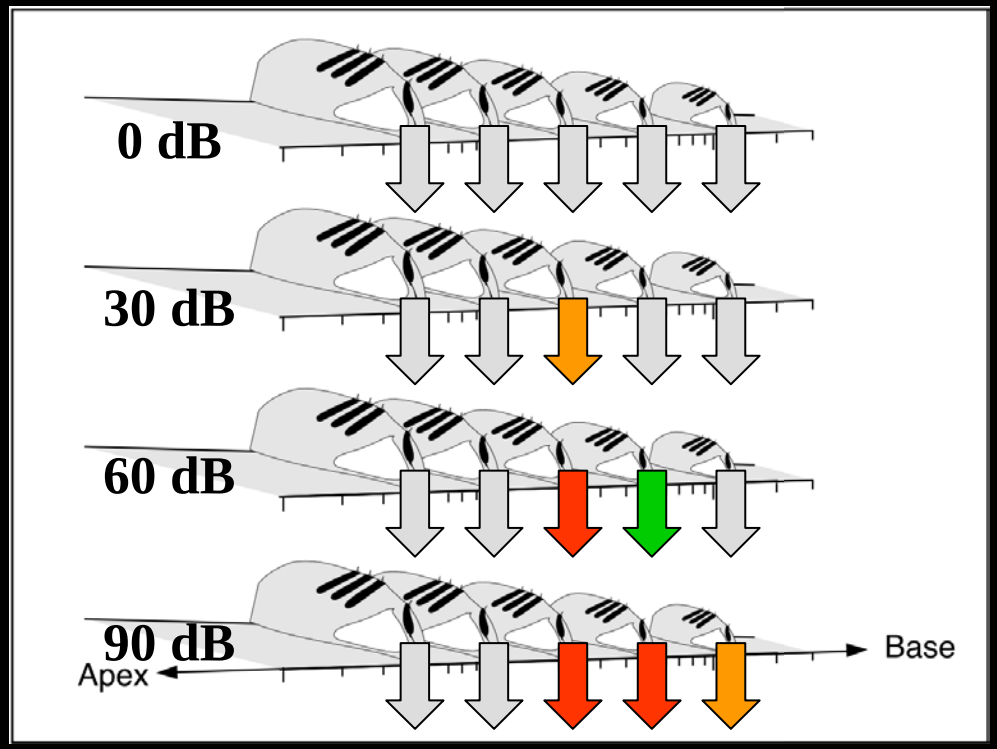




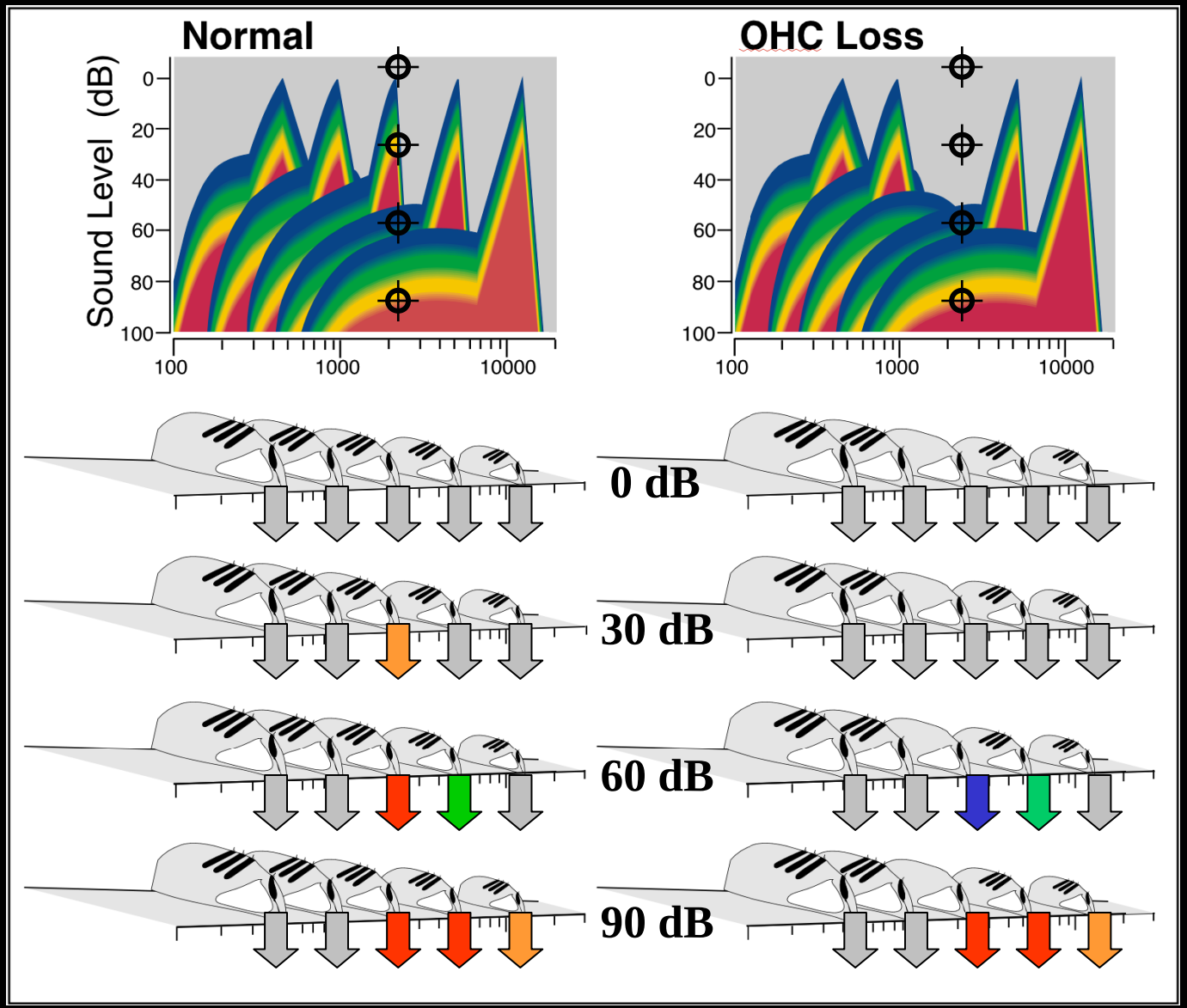


HC loss and loudness recruitment: Normal Ear





HC loss and loudness recruitment: OHC loss



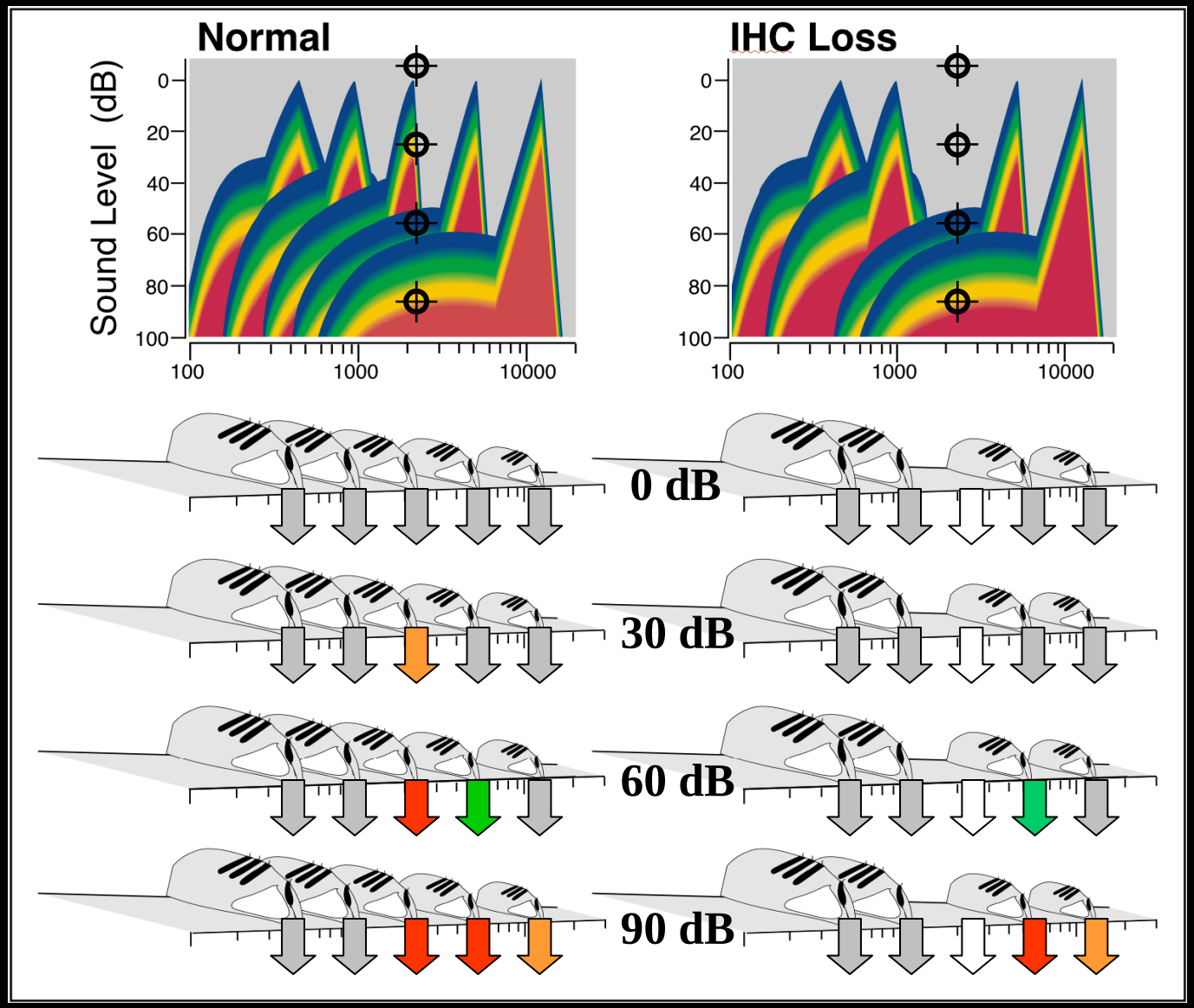
No response in either ear

No response in damaged ear

Less response in damaged ear

Identical response in both ears

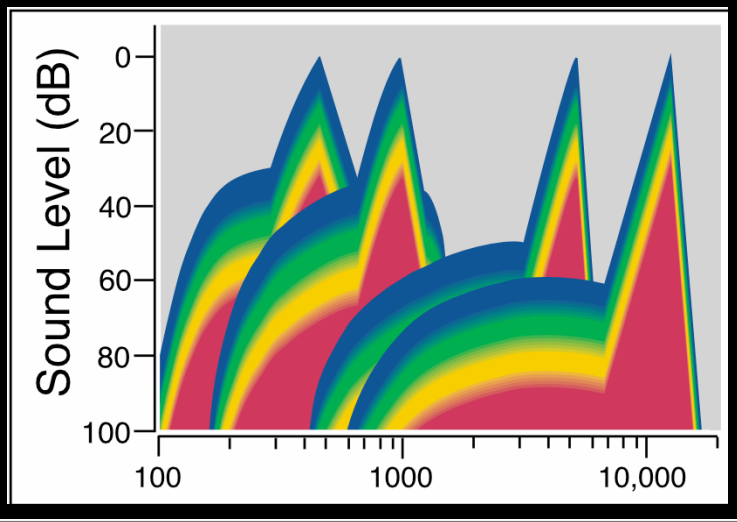
HC loss and pitch shift: IHC loss

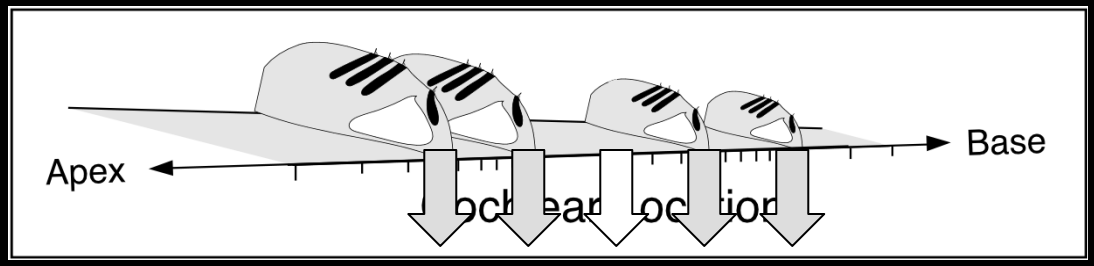


Response to 2500 Hz is carried by "wrong" fibers

Response pattern is never normal

IHC loss: SR and tinnitus ?



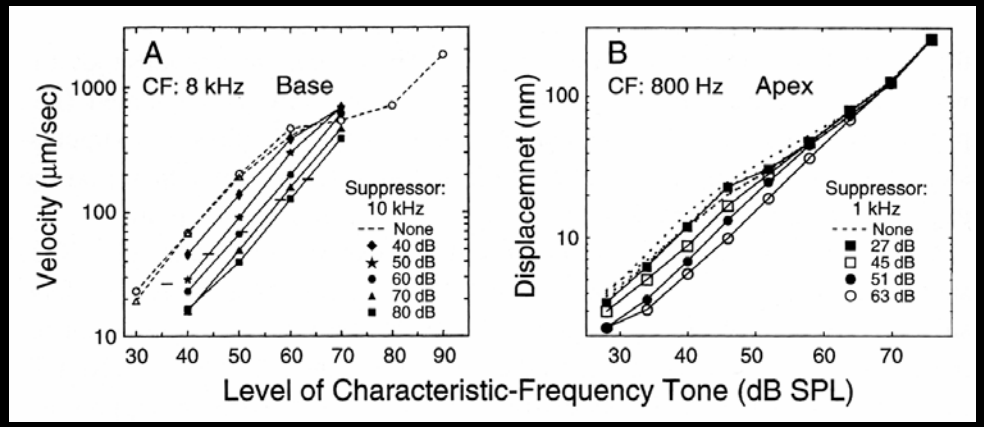


IHC loss eliminates spontaneous discharge in auditory nerve fibers

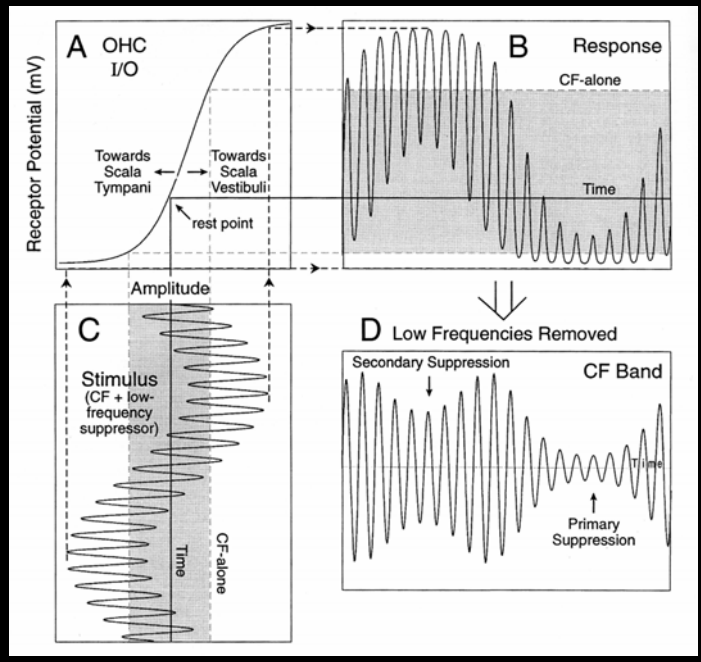
This silent band produces an abnormal response gradient in quiet

This gradient may be interpreted as a sound: TINNITUS

OHC loss and two-tone suppression



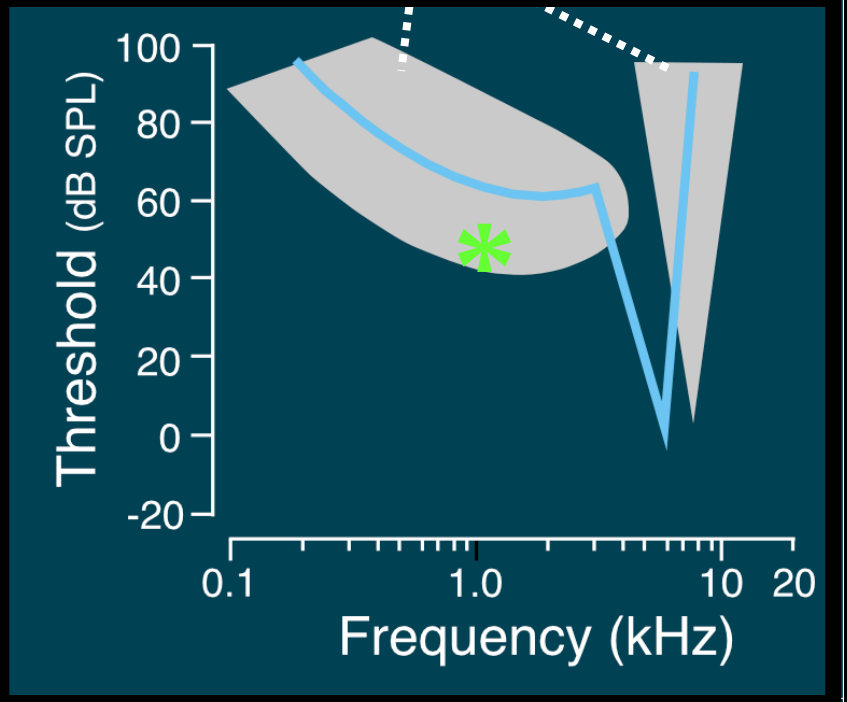
Two-tone suppression in BM response

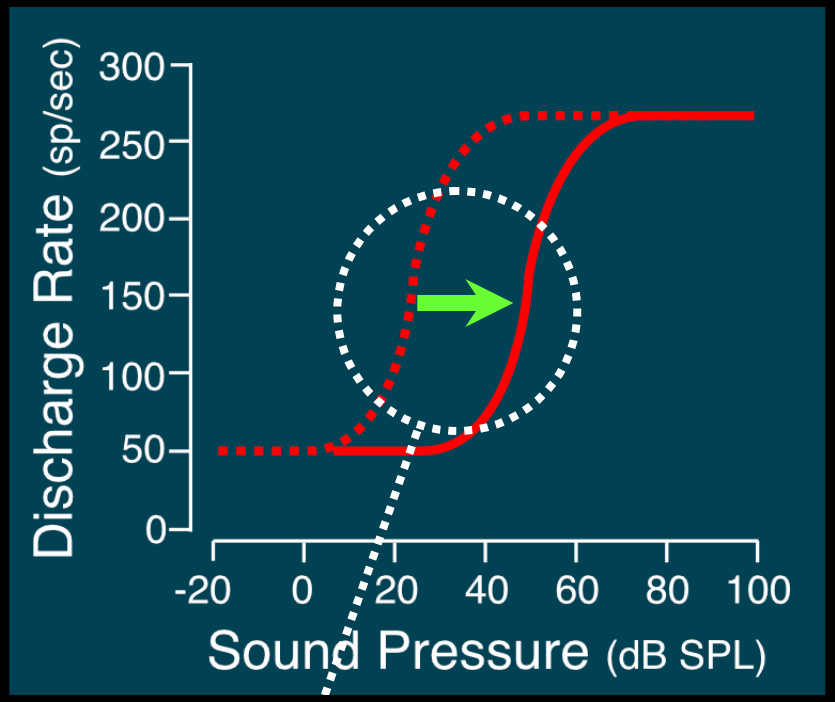


Arises from OHC transducer nonlinearity and its control of the OHC motors

Two-tone suppression in normal ear

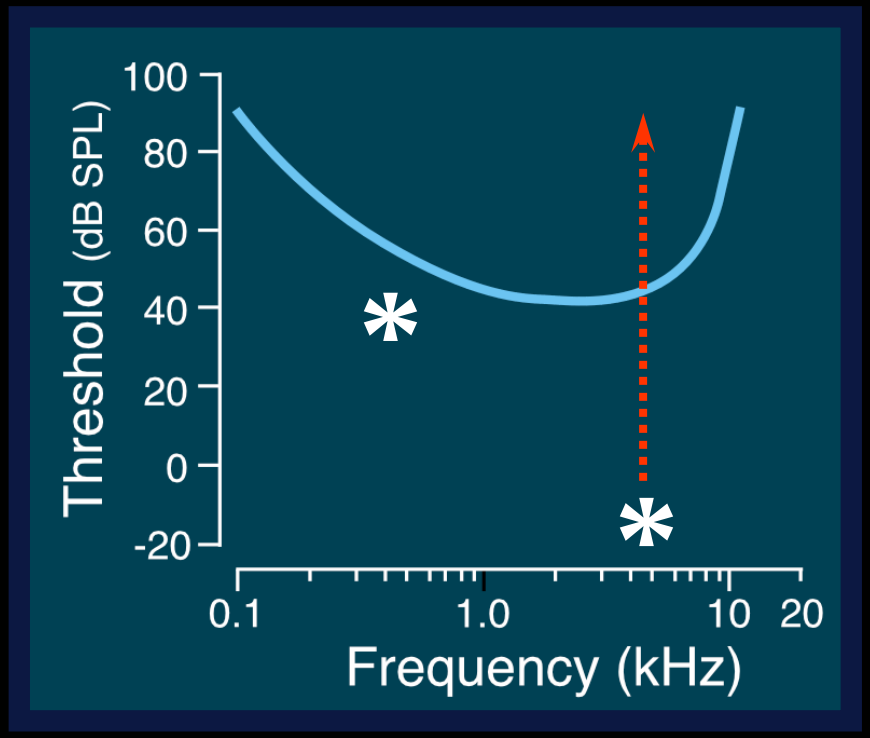
Two-Tone Suppression Contours

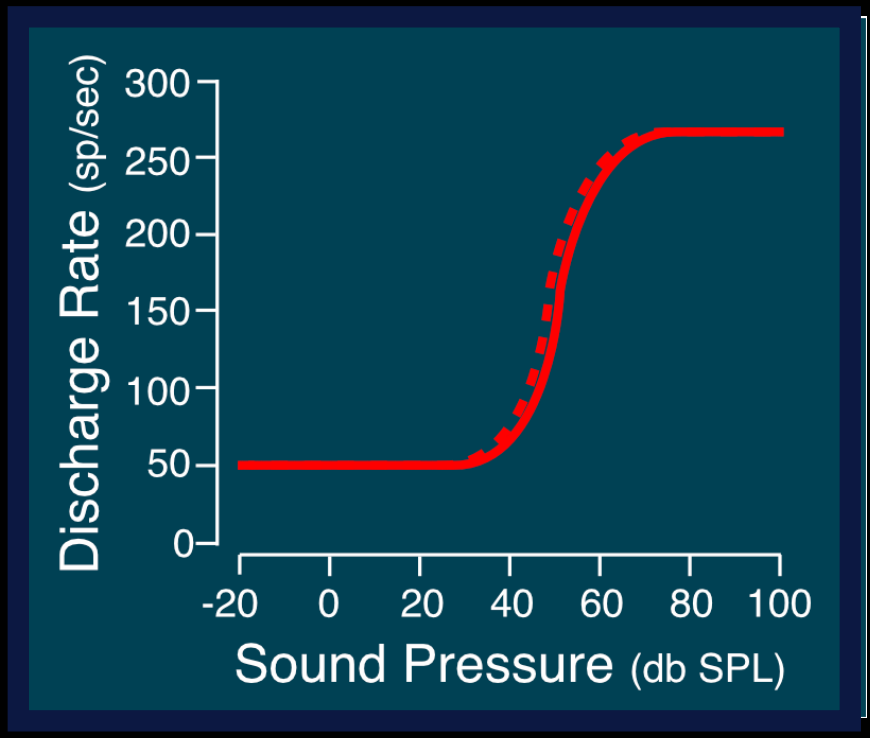




Dynamic Range Shift:
3 dB/dB

OHC loss - Loss of two-tone suppression





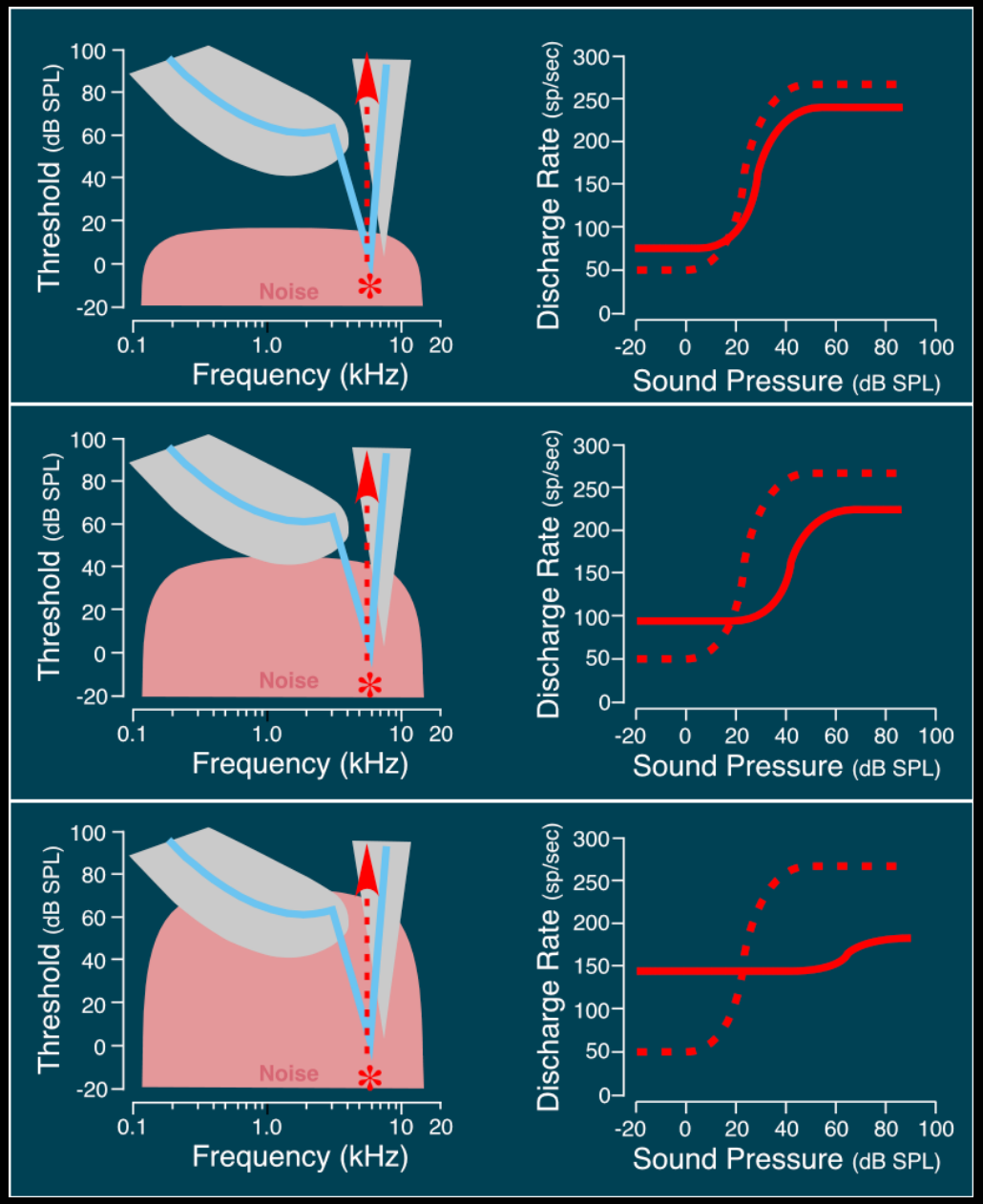
Suppressive effects are a form of anti-masking

With suppression, noise can increase to > 20 dB re threshold without saturation

10 dB

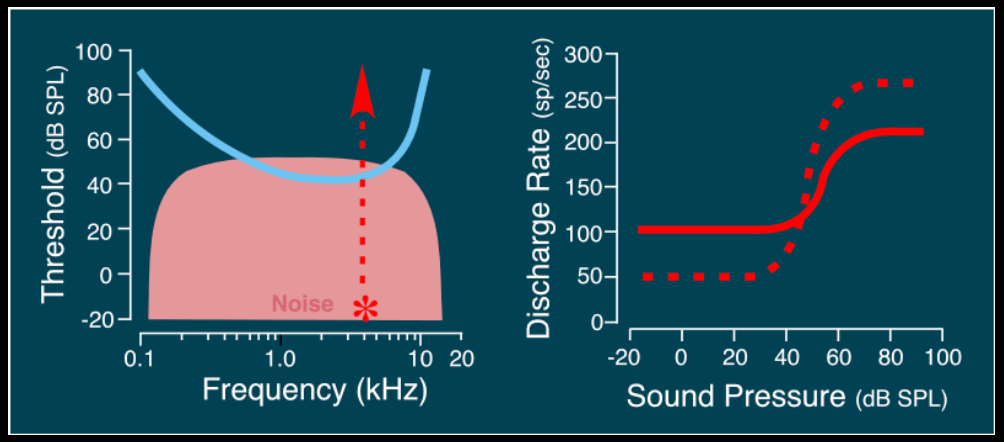
40 dB

70 dB



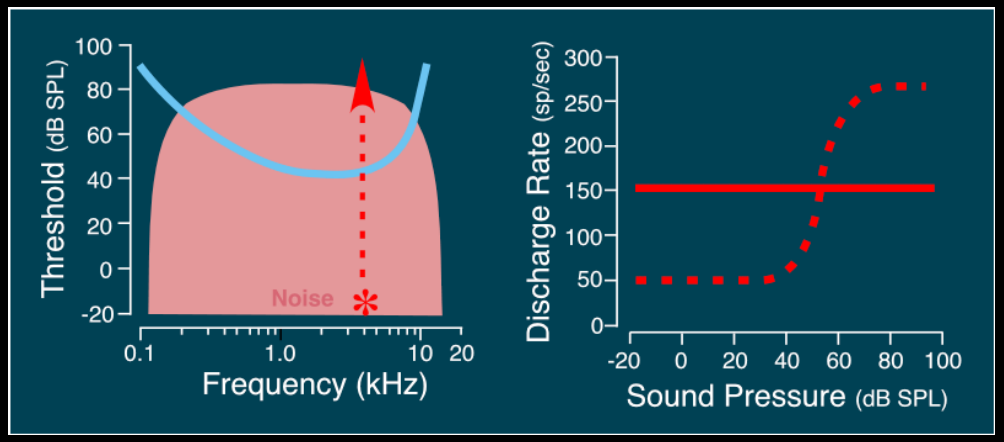
OHC loss - Loss of Dynamic Range Shift in Noise

10 dB



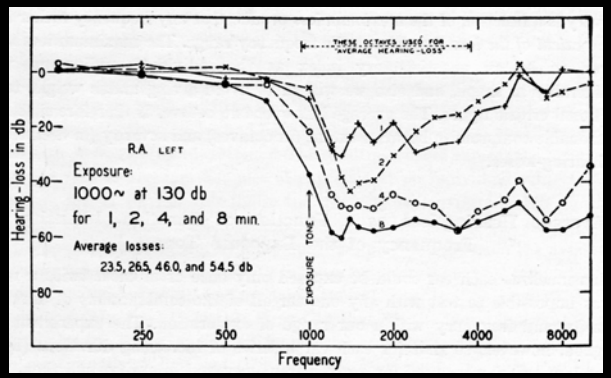
40 dB

Without suppression, fiber saturates as noise level grows *re* noise threshold.

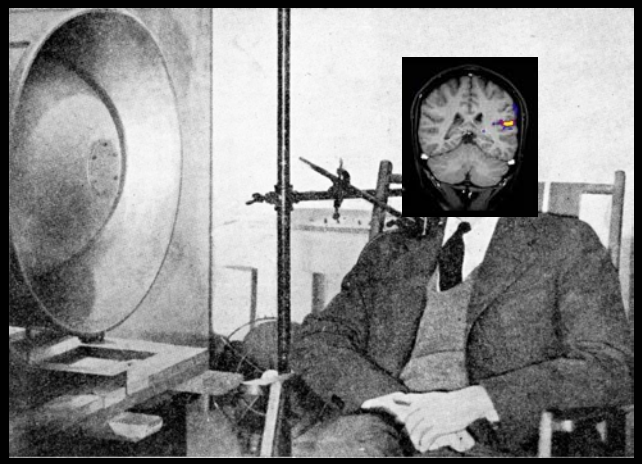


SNHL: Perceptual Correlates

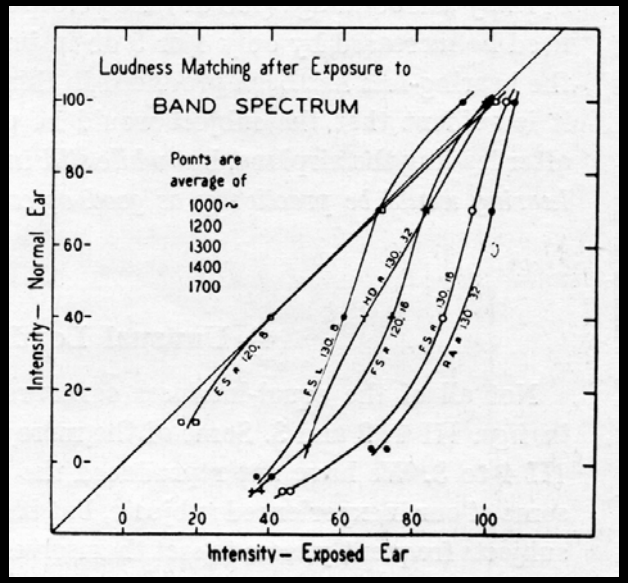
Threshold shifts



Tinnitus



Loudness Recruitment



Problems in Noise

Pitch Shifts