



Penn Medicine

# Can You Hear Me Now?

AN INTRODUCTION TO HEARING LOSS AND HEARING AIDS

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# Today's Agenda

- Basics of hearing loss
- Impact of hearing loss, both physically and mentally
- Introduction to Hearing Aids
- Other treatment options
  - Implantable Devices
- Tinnitus

# Division of Audiology

## DEPARTMENT OF OTORHINOLARYNGOLOGY

# Hearing and Balance Center

- 17 audiologists in 4 locations
- Provide comprehensive hearing and balance testing, as well as treatment options including hearing aids and implantable hearing devices



# Why Care About Hearing?

# Prevalence of Hearing Loss

- 15% of American adults (~37.5 million) aged 18 years and older report difficulty hearing
- “*One in eight people* in the United states aged 12 years or older has hearing loss in both ears, based on standard hearing examinations”
- Nearly 25% of Americans ages 65-74 (and 50% over age 75) have hearing loss severe enough to affect daily life





**14%**

of adults  
**aged 20 to 69**  
in 2011–2012

Prevalence of hearing loss has **declined slightly** from about **16%** in 1999–2004.

## Who is most at risk for hearing loss?

### Older Age Groups



Prevalence of hearing loss increases with age.

### Men



Men are about twice as likely as women to have hearing loss.

Hearing loss is defined as when the average threshold across four speech frequencies (0.5–1–2–4 kHz) is greater than 25 decibels hearing level. The

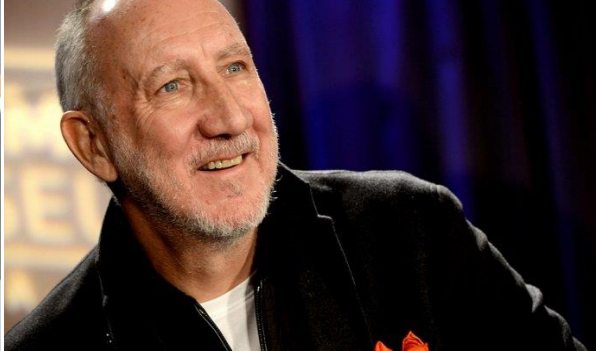
# Hearing Loss in the Media



Roger Daltrey



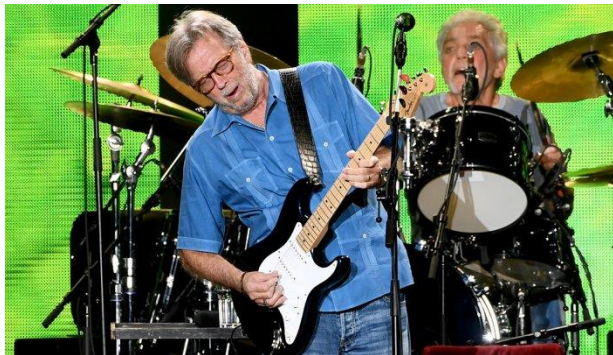
Whoopi Goldberg



Pete Townshend



Jane Lynch



Eric Clapton



Jodie Foster



William Shatner



Halle Berry



# Hearing Health Care

- Why is hearing health important?
  - Physical impact
  - Mental/psychological impact
  - Impact on overall quality of life

# Physical Impact of Hearing Loss

- Increased risk of falls
  - A mild degree of hearing loss triples the risk of accidental falls
  - 10 dB of additional hearing loss increases risk by 140%
- Theories about falls
  - Less awareness of environment and decreased spatial awareness due to fatigue
  - Hearing loss causes the brain to work harder, in turn taking away resources for gait and balance



# Mental Impact of Hearing Loss

- *Is There an Association Between Untreated Hearing Loss and Psychosocial Outcomes? Jayakody et al 2022*
  - **Cognitive impairment** (Jayakody et al., 2017)
  - **Dementia** (Dalton et al., 2003; Lin et al., 2011)
  - **Alzheimer's disease** (Lin et al., 2011)
  - **Social isolation** (Strawbridge et al., 2000)
  - **Depression, anxiety and stress** (Jayakody et al., 2018)
  - **Poor quality of life** (Dalton et al., 2003)
  - **Physical inactivity** (Gispen et al., 2014)

Adults with untreated hearing loss are more likely to develop dementia.



# Hearing loss can impact every aspect of our lives

FAMILY

PHONE  
CALLS

WORK

TV &  
RADIO

SOCIAL  
SETTINGS

ERRANDS

PLACES  
OF  
WORSHIP

MEETINGS

DOCTOR'S  
OFFICE

CAR

# Hearing Loss 101



Outer Ear

Middle Ear

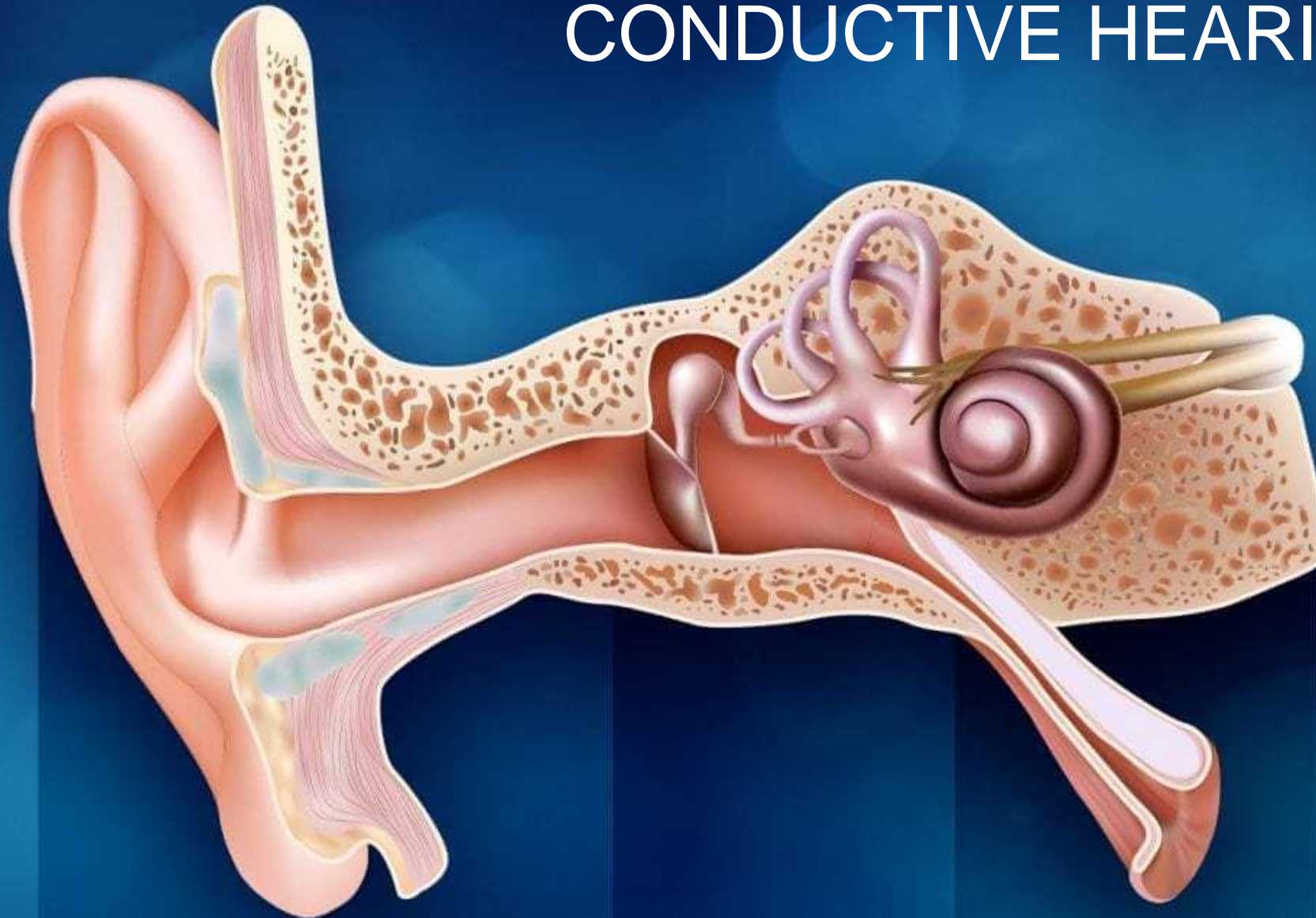
Inner Ear

# Hearing Loss Types

- Conductive
- Sensorineural
- Mixed



# CONDUCTIVE HEARING LOSS



Outer Ear

Middle Ear

Inner Ear

# SENSORINEURAL HEARING LOSS



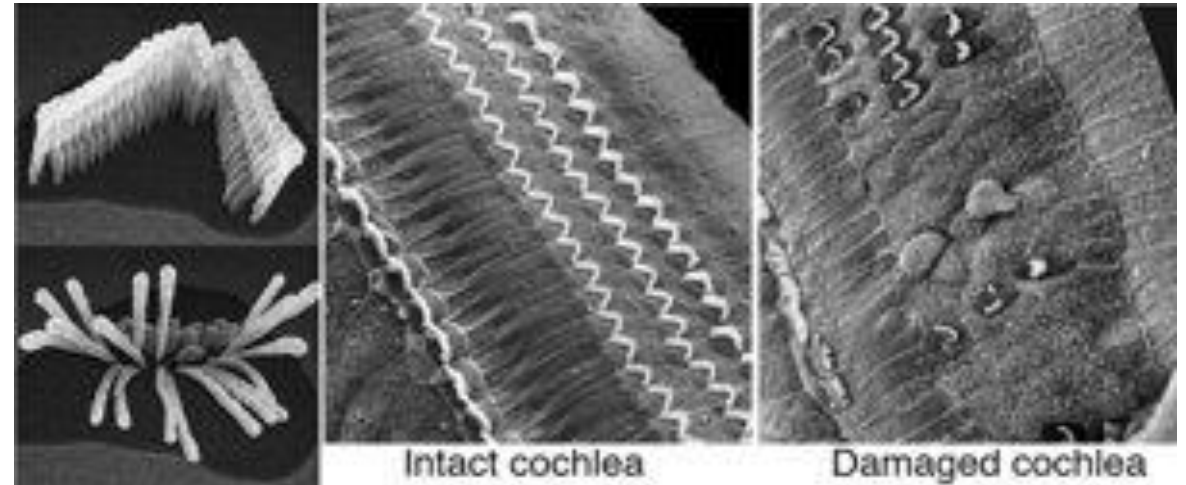
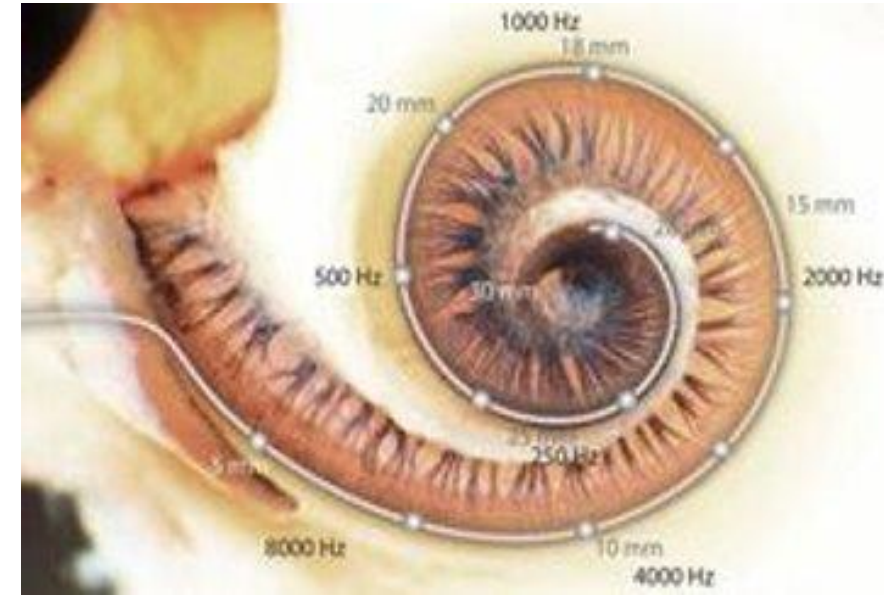
Outer Ear

Middle Ear

Inner Ear

# Sensorineural Hearing Loss

- Most common type of age-related hearing loss, called presbycusis
- Involves damaged or destroyed hair cells in the cochlea (sensory hearing organ) which cannot be regrown



# MIXED HEARING LOSS



Outer Ear

Middle Ear

Inner Ear

# How is Hearing Assessed?

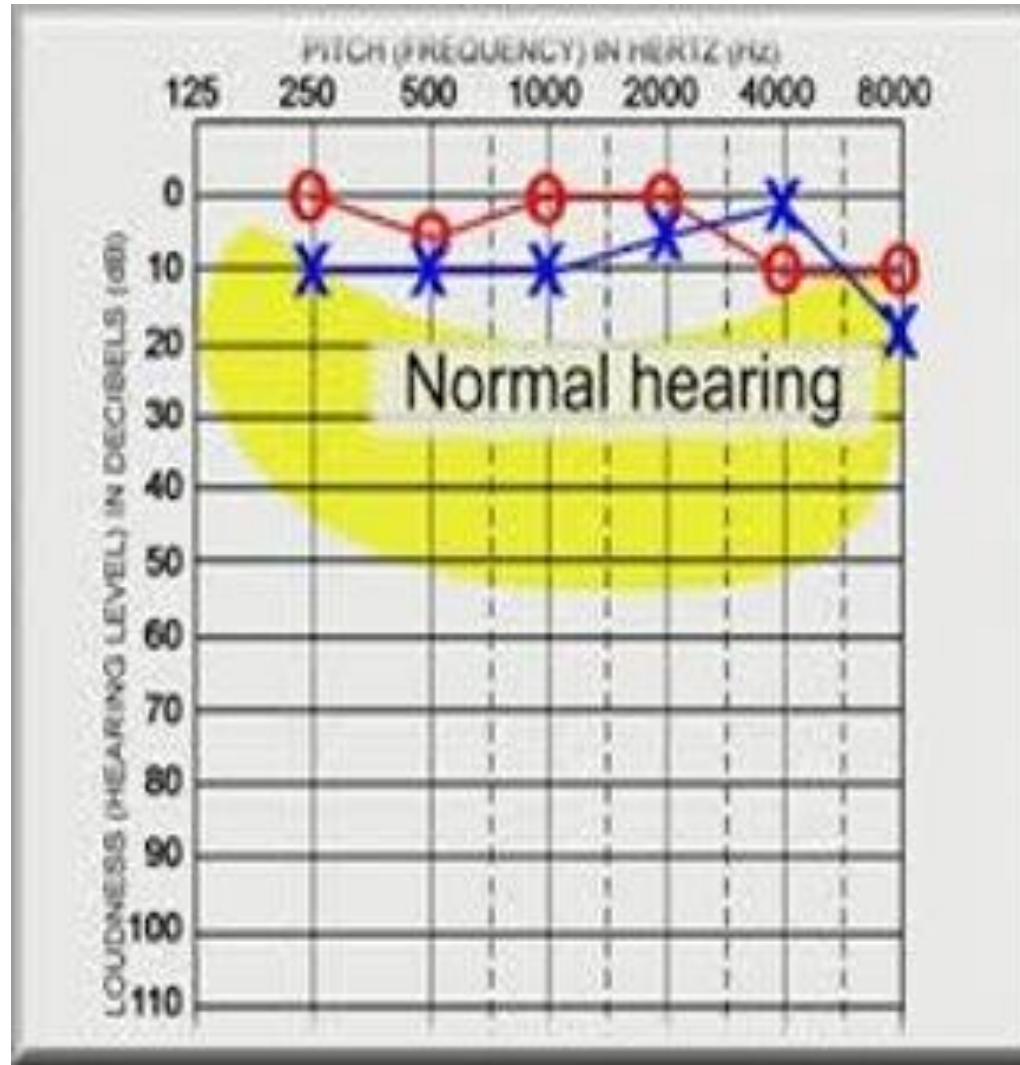
- Audiologic evaluation uses a series of tests to assess multiple parts of the hearing system to determine type, degree and configuration of hearing loss
- Plotted on an audiogram
  - Visual display of softest sounds a person can hear at different pitches

Low (Bass)      FREQUENCY/PITCH      High (Treble)

Soft

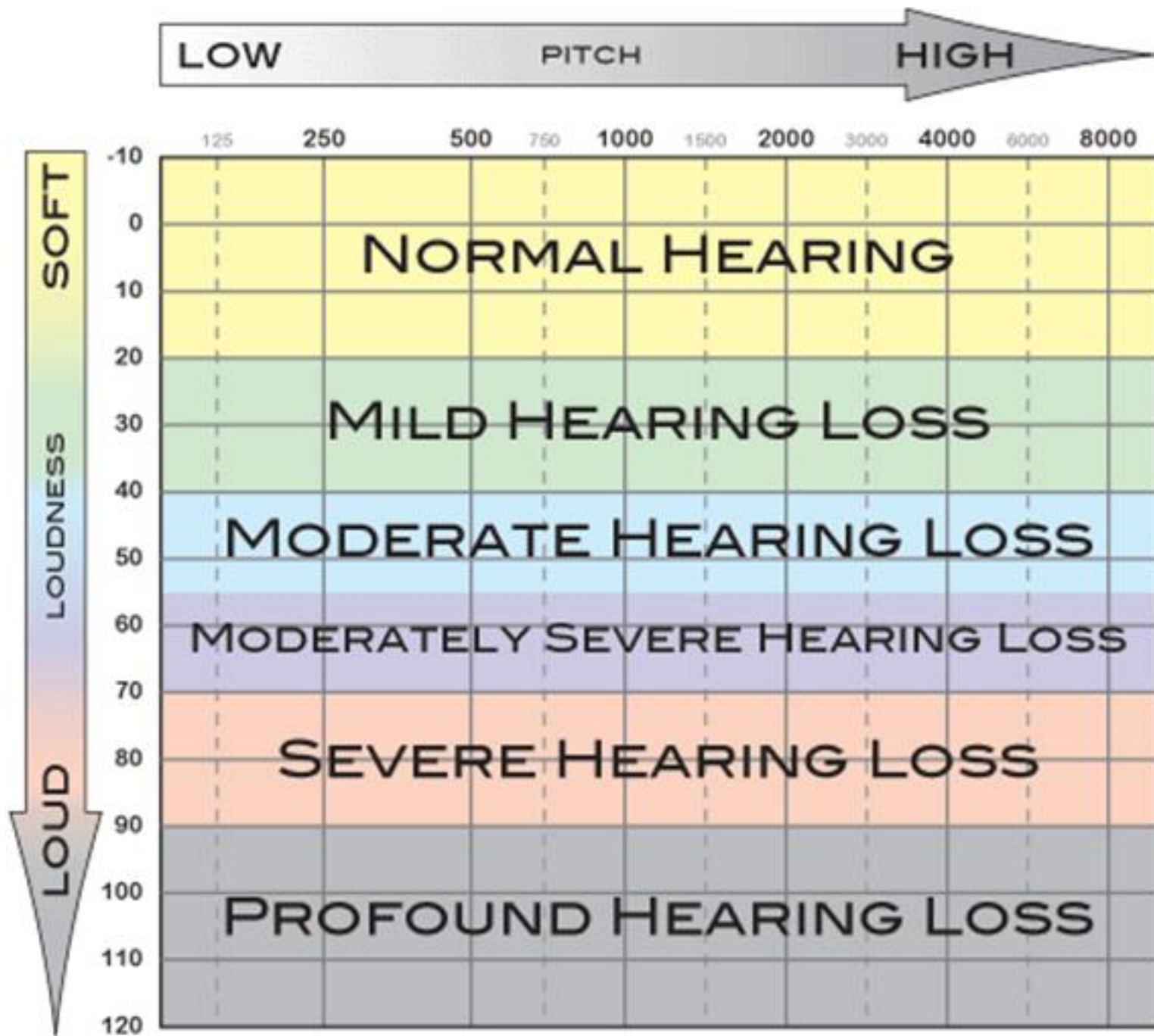
V  
O  
L  
U  
M  
E

Loud

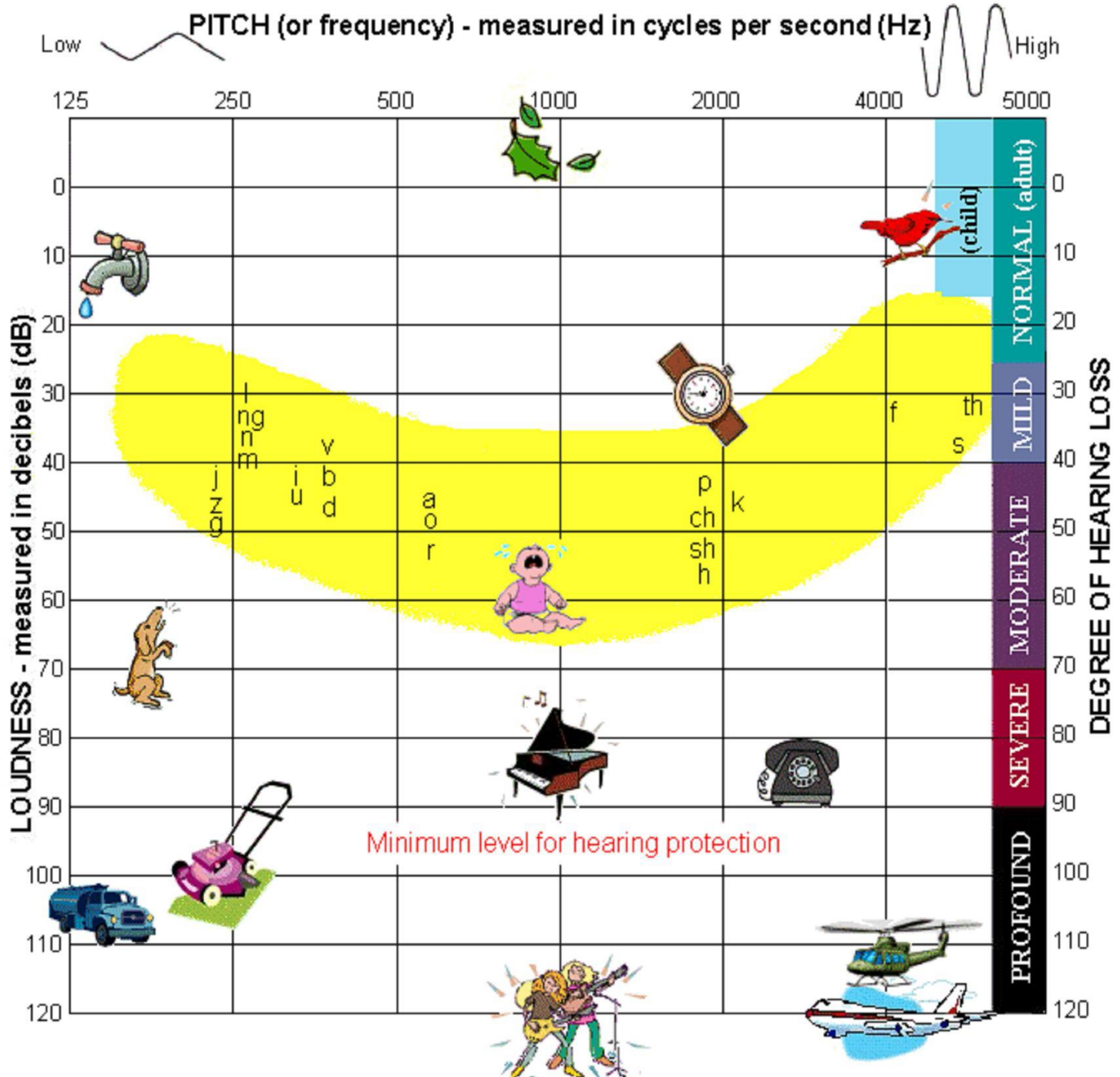


Red O's = Right ear

Blue X's = Left ear

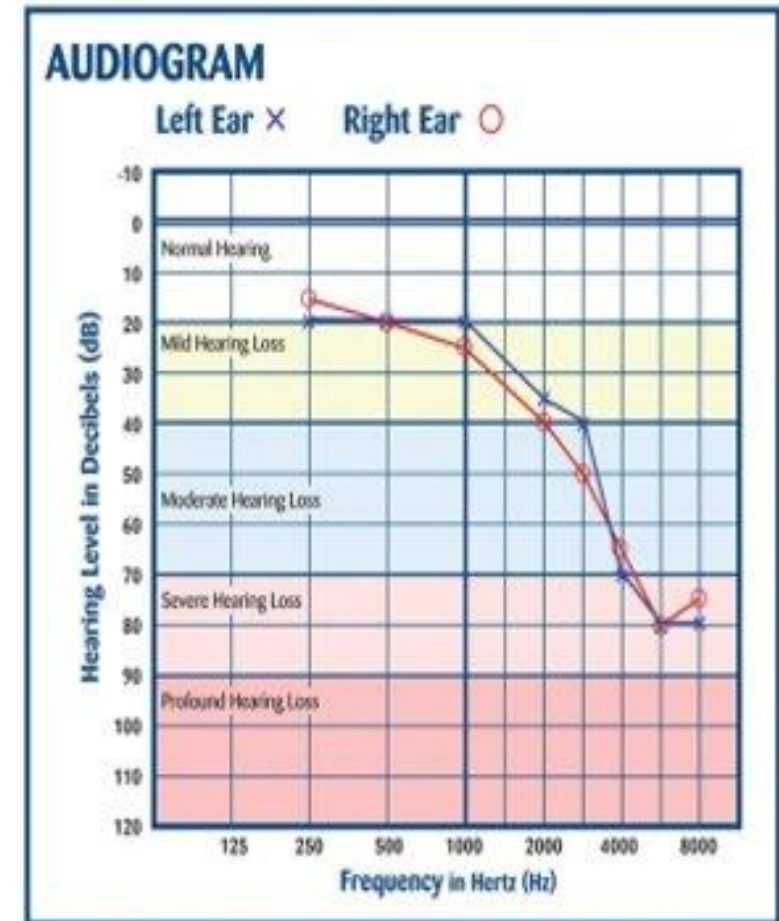
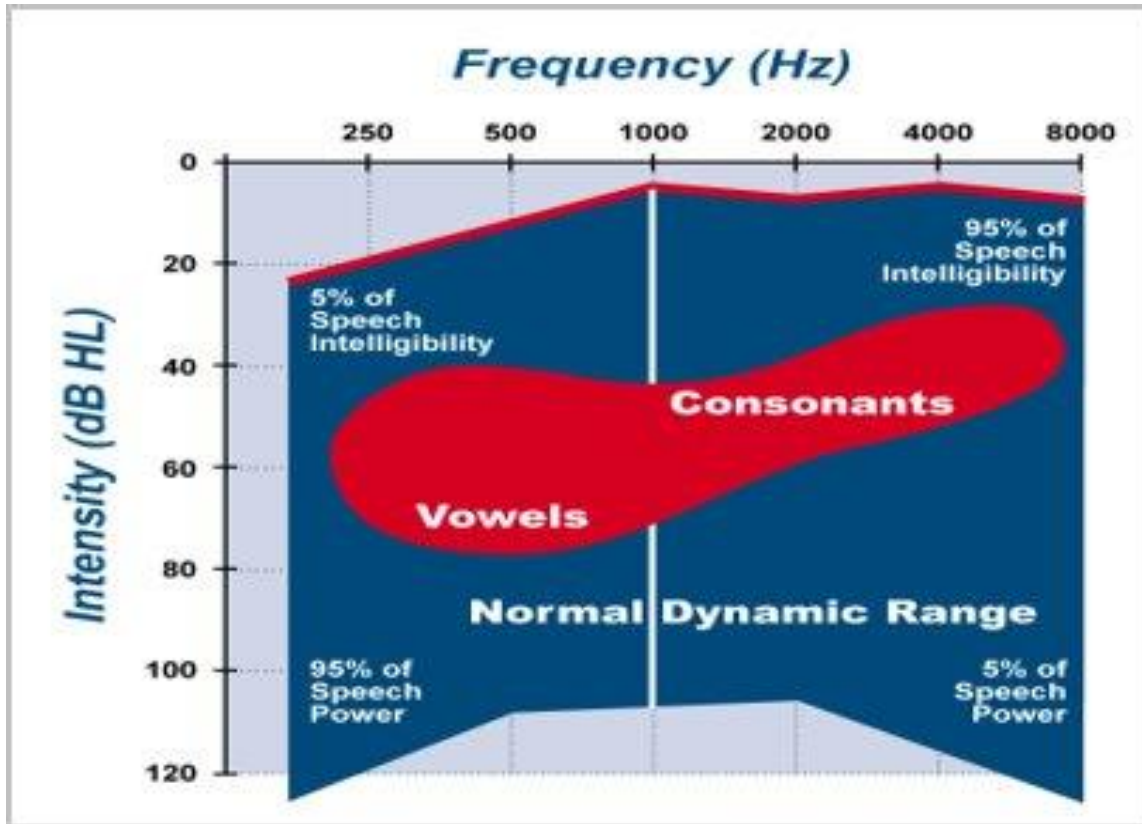


The greater the degree of hearing loss, the greater the amount of hair cell damage/loss





# Speech and hearing science help us estimate the impact of hearing loss on one's ability to understand speech



# Hearing Aids

# Prescriptive Hearing Aids

- Electronic medical device that amplifies sound based on an individual's hearing loss and communication needs
- Recommended and programmed by a hearing care professional
- Provide improved speech clarity and better hearing in noise



# Hearing Aid Styles

**IIC**  
invisible-in-the-canal



**CIC**  
completely-in-the-canal



**ITC**  
in-the-canal



**ITE**  
in-the-ear



**OPEN**  
open fit, behind-the-ear



**RITE**  
behind-the-ear



**BTE**  
behind-the-ear with ear mould

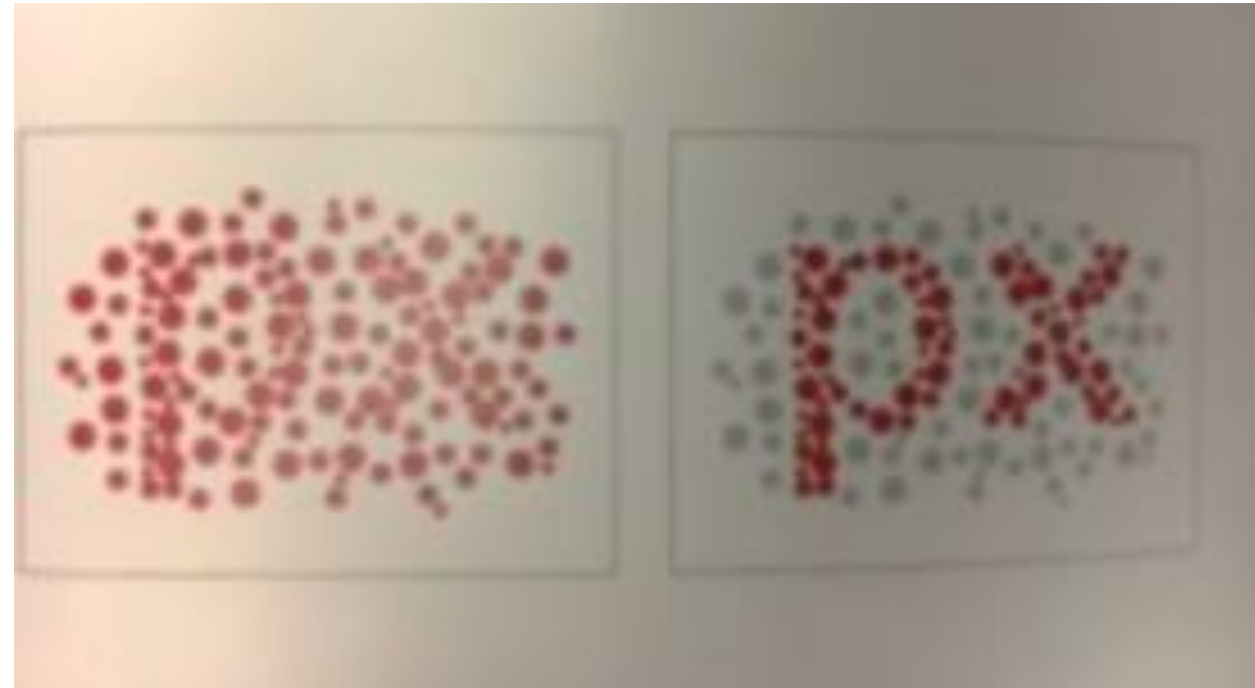


**POWER**  
behind-the-ear with high amplification



# Hearing Aid Technology

- **Left picture** - what speech in noise may look like to our brain
- **Right picture** - what speech in noise with hearing aid technology/resolution can do
- The better the hearing aid technology, the better the resolution of speech



# Hearing Aid Technology

- Main goal – improve speech intelligibility
- Algorithms created using speech and hearing science to try to compensate for hair cell damage and improve speech clarity in all listening environments

# Hearing Aid Technology in Quiet

- Main goal is to make speech and sound audible and recognizable to the brain based on the individual's hearing loss.
- Maintain fidelity of sound and relationship between soft, medium and loud sound to improve speech recognition.

# Hearing Aid Technology in Noise

- Waveform of speech and background noise are different
- Hearing aid makes comparative calculation to favor speech signal and filter noise to extent possible without degrading speech





# Waveforms of Speech and Noise



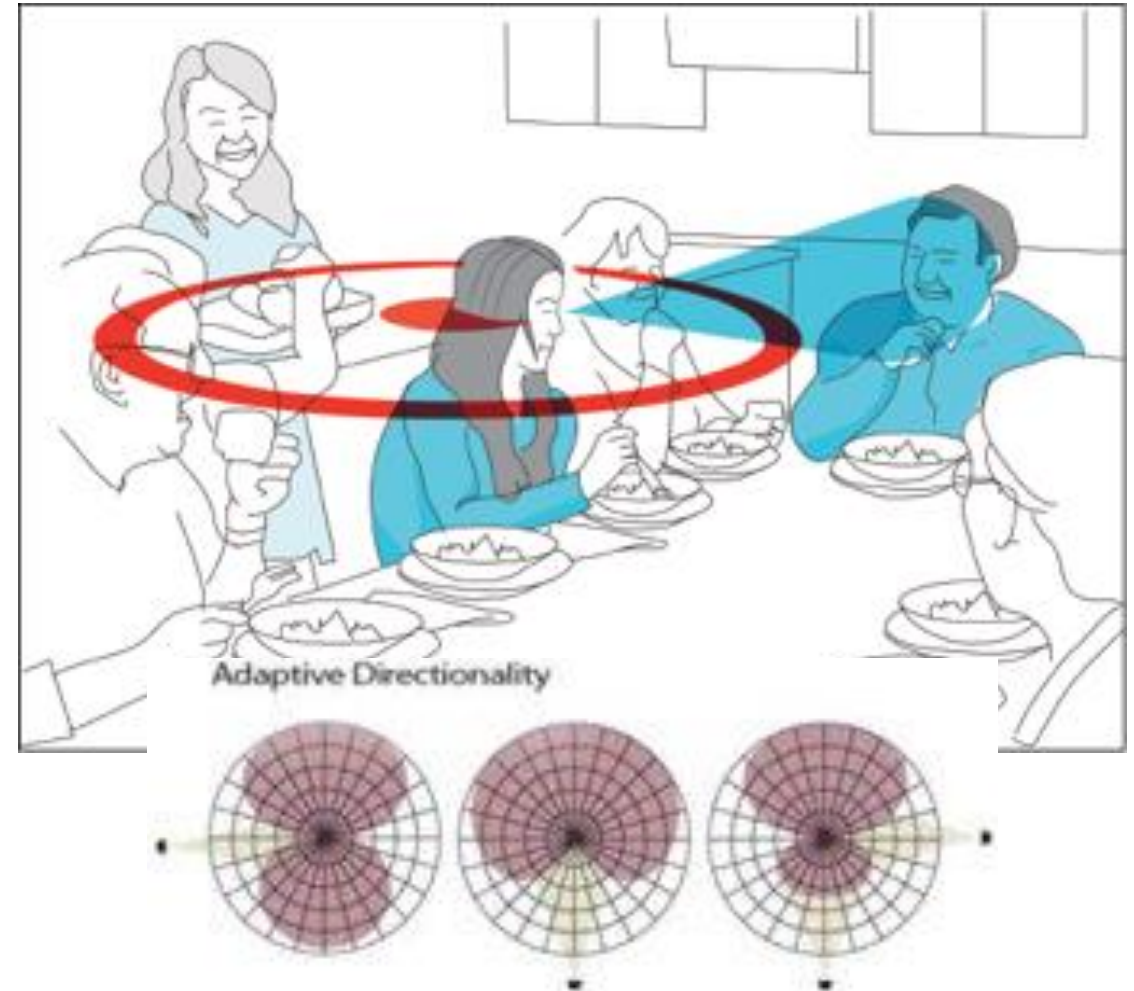
Speech Signal in Quiet



Speech Signal in Noise  
(pink speech, white noise)

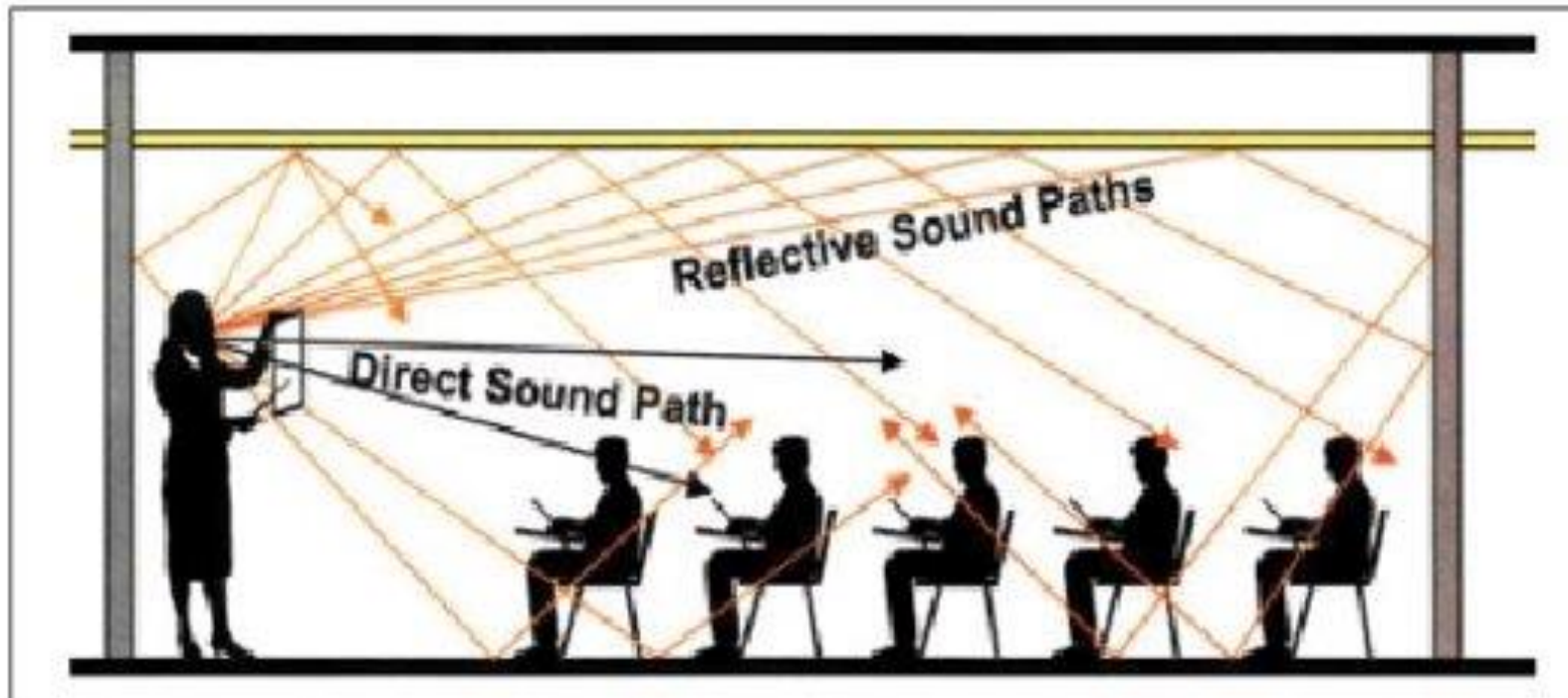
# Directional Microphones

- Hearing aid microphones can automatically or manually focus where speech is detected
- Can give the perception of increased volume similar to cupping back of your ear



# Hearing Aid Technology

- Some manufacturers can cancel out reverberating sound
  - Recognition of same signal within milliseconds and mathematically cancelling it out



# Levels of Hearing Technology

- Simple amplifiers (average range ~ \$40-\$400 per ear)
  - Make everything louder regardless type of signal and direction
- Basic technology (average range ~ \$800-\$1600 per ear)
  - Automatic processing, but best for those needing help in more controlled (less variable) listening environments (1:1, places of worship, television).
- Mid-level technology (average range ~ \$1600-\$2800 per ear)
  - Automatic and designed for a wider variety of average social environments
- Premium technology (average range ~ \$2800-\$3800 per ear)
  - Incorporating the highest number of features and formulas to accommodate the widest variety and most demanding listening environments.

# Newer Technology

91% satisfaction rate

in the US for hearing aids obtained within past few years  
shows effectiveness and improvements with newer technology

yet...

Only about 30% of people

in the U.S. who need hearing aids get them (this % is higher than most countries)

Marketrak 9:

<http://www.hearingreview.com/2015/05/introduction-markettrak-ix-new-baseline-hearing-aid-market/>

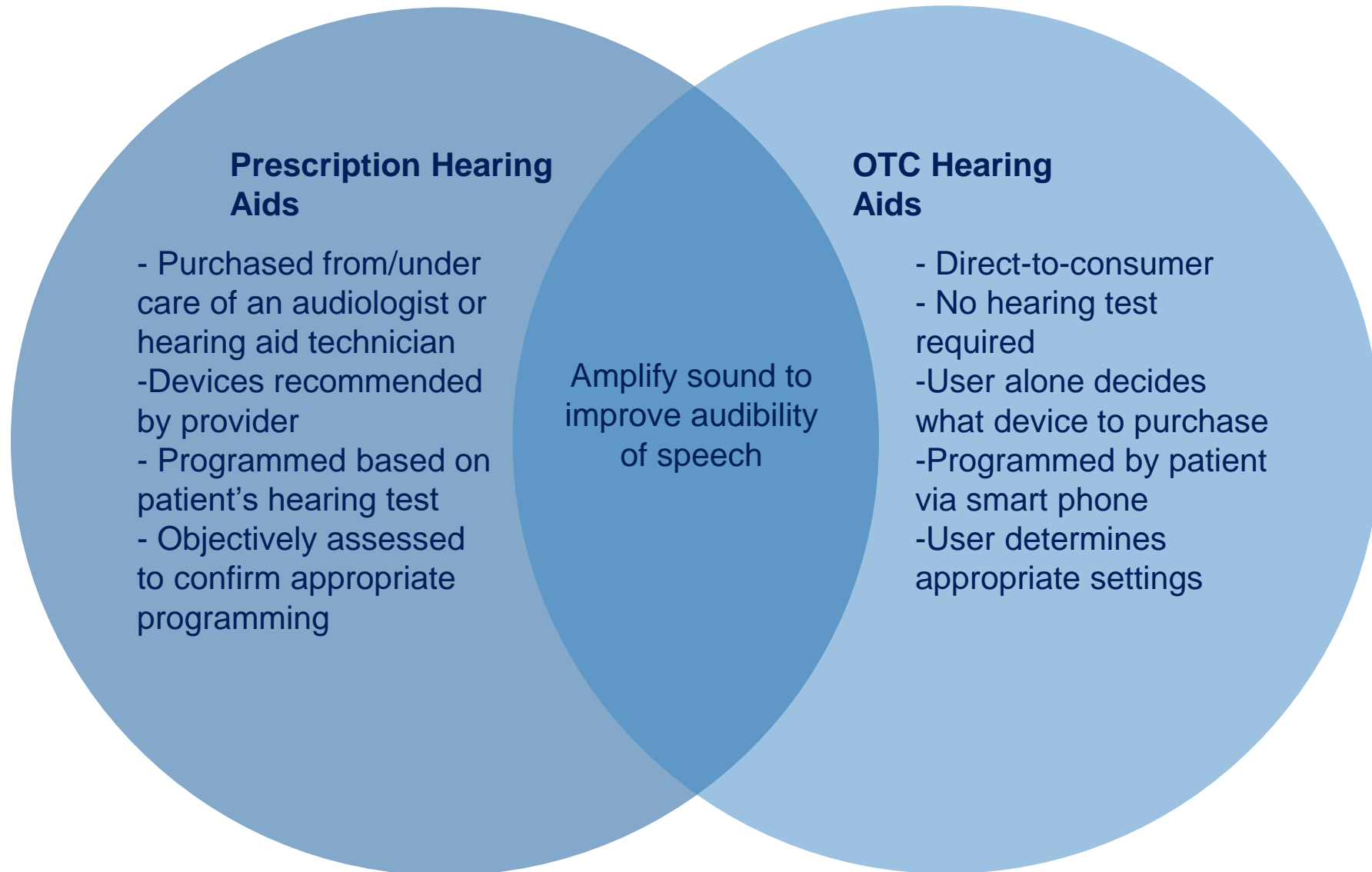
# Other Considerations

- Individual communication needs
  - Remote microphone systems and other accessories
- Other physical concerns (dexterity, vision)
  - Rechargeable devices
- Convenience
  - Compatibility with phone and other Bluetooth device
- Cosmetics

# Over-the-Counter (OTC) Hearing Aids

- Direct-to-consumer devices for individuals with *perceived mild to moderate hearing loss*
- FDA approved since October 2022







# Implantable Hearing Devices

# Bone Conduction Hearing Aids

- Surgically implanted device
- Translates sound into vibration to access the inner ear
  - Don't need anything in the ear
  - For people with conductive/mixed hearing loss and single sided deafness (SSD)



# Cochlear Implants

- Electronic medical device for people with moderate to profound hearing loss who no longer benefit from hearing aids
- Extensive evaluation process that includes an audiologist and otologist
- Two parts
  - Surgical implant in the cochlea (hearing organ)
  - External processor (picture)



**Reasonable accommodations for  
instructors/effects of hearing loss at  
work**

**Are we eligible for assistance in the  
classroom?**

# Reasonable Accommodations

The ADA requires reasonable accommodations as they relate to three aspects of employment:



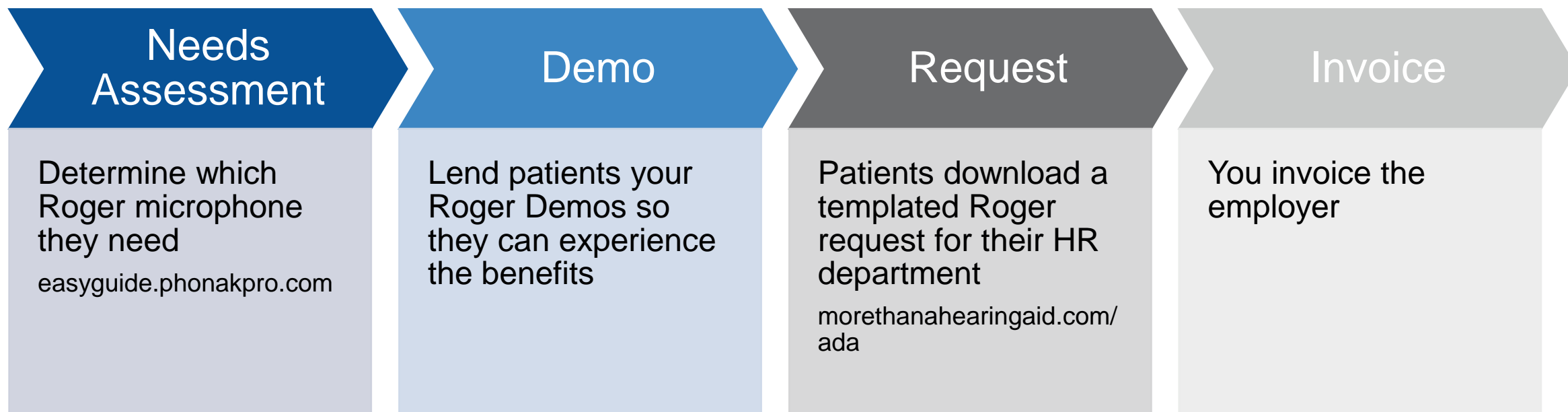
1. Ensuring equal opportunity in the application process;
2. Enabling a qualified individual with a disability to perform the essential functions of a job;
3. Making it possible for an employee with a disability to enjoy equal benefits & privileges of employment.

# Roger system

- Roger is just one of the hearing aid technology systems we dispense
  - It is a wireless microphone system that transmits speech to hearing aids and cochlear implants
- Considered a reasonable accommodation for hearing loss by the FDA



Americans with Disabilities act of 1990 (ADA) allows employees with a disability (hearing loss) to request the reasonable accommodations (Roger system) to help them perform their job better



# Different jobs: Different dynamics





# Tinnitus

# Tinnitus

- Ringing sound in the ear(s) in the absence of an external source
  - Ringing, buzzing, hissing, roaring, whistling, static, clicking, pulsing, etc.
  - Constant or intermittent, can be fluctuating
- Can be in the presence or absence of hearing loss
- Possible causes
  - Excessive loud noise, certain medications, blood/heart issues, ear/sinus infections, etc.



# Tinnitus Management

- Sound masking
- Hearing aids/cochlear implants to increase access to sound
- Cognitive Behavioral Therapy (CBT)
- Tinnitus Retraining Therapy (TRT)



# Cognitive Behavioral Therapy (CBT)

- Goal is to help promote habituation
  - Reduce or eliminate negative emotion response/reaction to tinnitus
  - Slowed by high levels of stress, arousal, general emotion around the tinnitus
- Robust evidence that CBT is effective in helping manage tinnitus and making bothersome tinnitus less bothersome
- Does not necessarily make tinnitus less loud

# Tinnitus Retraining Therapy (TRT)

- Combination of CBT and sound masking
  - Both aid in habituation and work in tandem
- Unfortunately lacking substantial amounts of research
- CBT alone and TRT are effective, so treatment can be personalized

# I Think I Need a Hearing Aid...

# The Hearing Aid Assessment at Penn: What can I expect?

- Additional testing beyond the hearing test
- Majority of appointment is discussion of benefits and limitations of hearing aids and current available features
  - Style, technology, optional circuitry available, impact of tinnitus, cost of devices
- \$250 out of pocket cost for appointment (not billable to insurance)

# University of Pennsylvania Benefit

- UPenn (current and retired) and UPHS (current) employees and faculty are given 15% off the cost of the hearing aids
- In addition:
  - **UPenn employees and faculty:** \$4000 toward hearing aids every 3 years for the following plans:
    - Aetna HD plan, Aetna POSII, Aetna POS Standard, Keystone HMO, PennCare/Personal Choice
    - For questions, contact Benefit Solutions Center at 866-799-2329 or email [HRbenefits@hr.upenn.edu](mailto:HRbenefits@hr.upenn.edu)
  - **UPHS employees and faculty:** \$2500 toward hearing aids every 3 years
    - Independence Blue Cross/BS Penn Care/Personal Choice PPO Plan
    - For questions contact [BenefitQuestions@penncare.upenn.edu](mailto:BenefitQuestions@penncare.upenn.edu)



# Next Step

- Hearing Aid Fitting
  - Programming and orientation
    - Real ear measures to verify settings
  - 45 trial period with devices
    - Devices are purchased at the fitting but can be returned for a full refund minus a ~\$250 restocking fee
    - Typically scheduled for 1-2 follow up appointments during the trial period for adjustments, reviewing care/use, etc.




# Audiology

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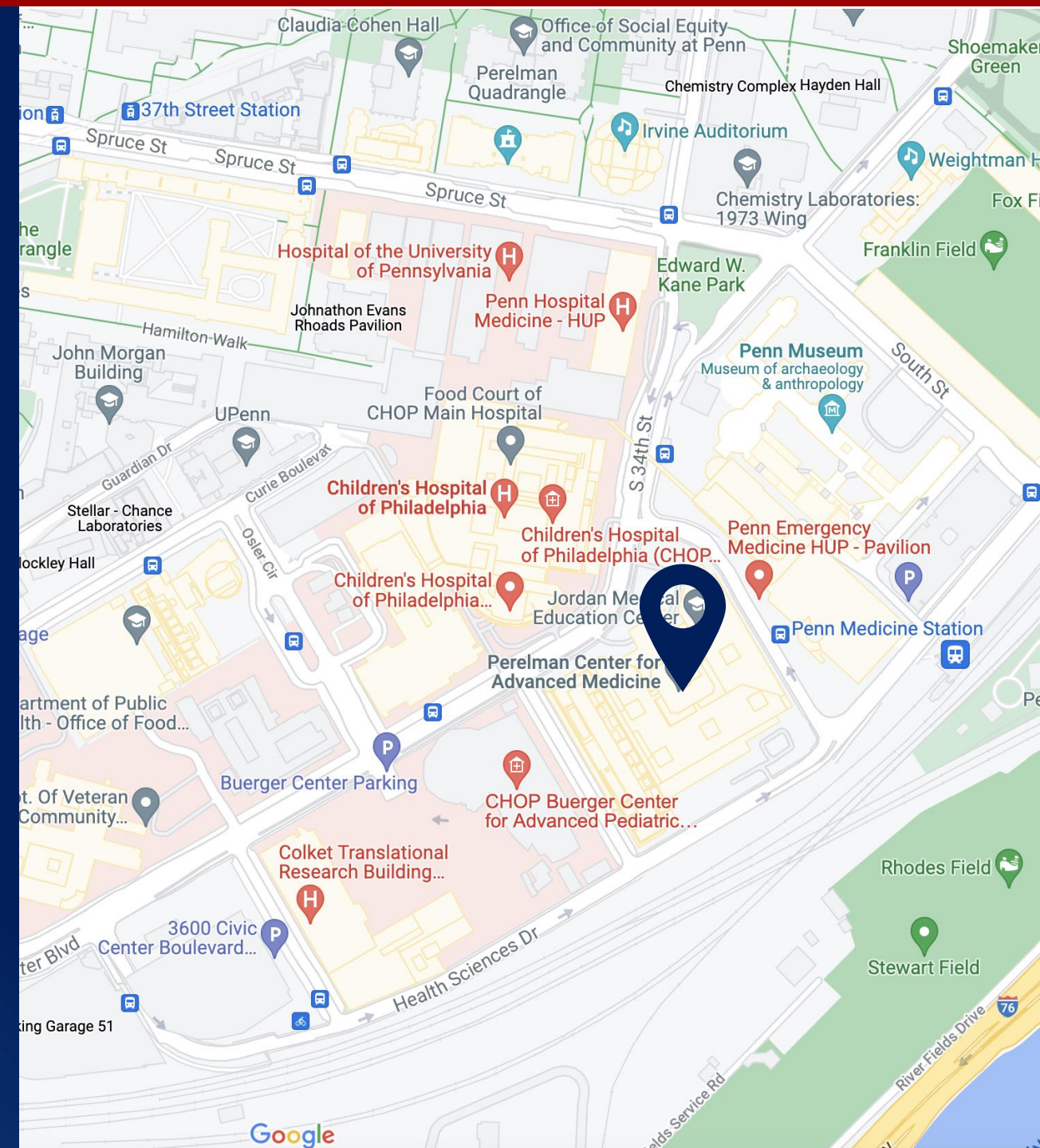
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