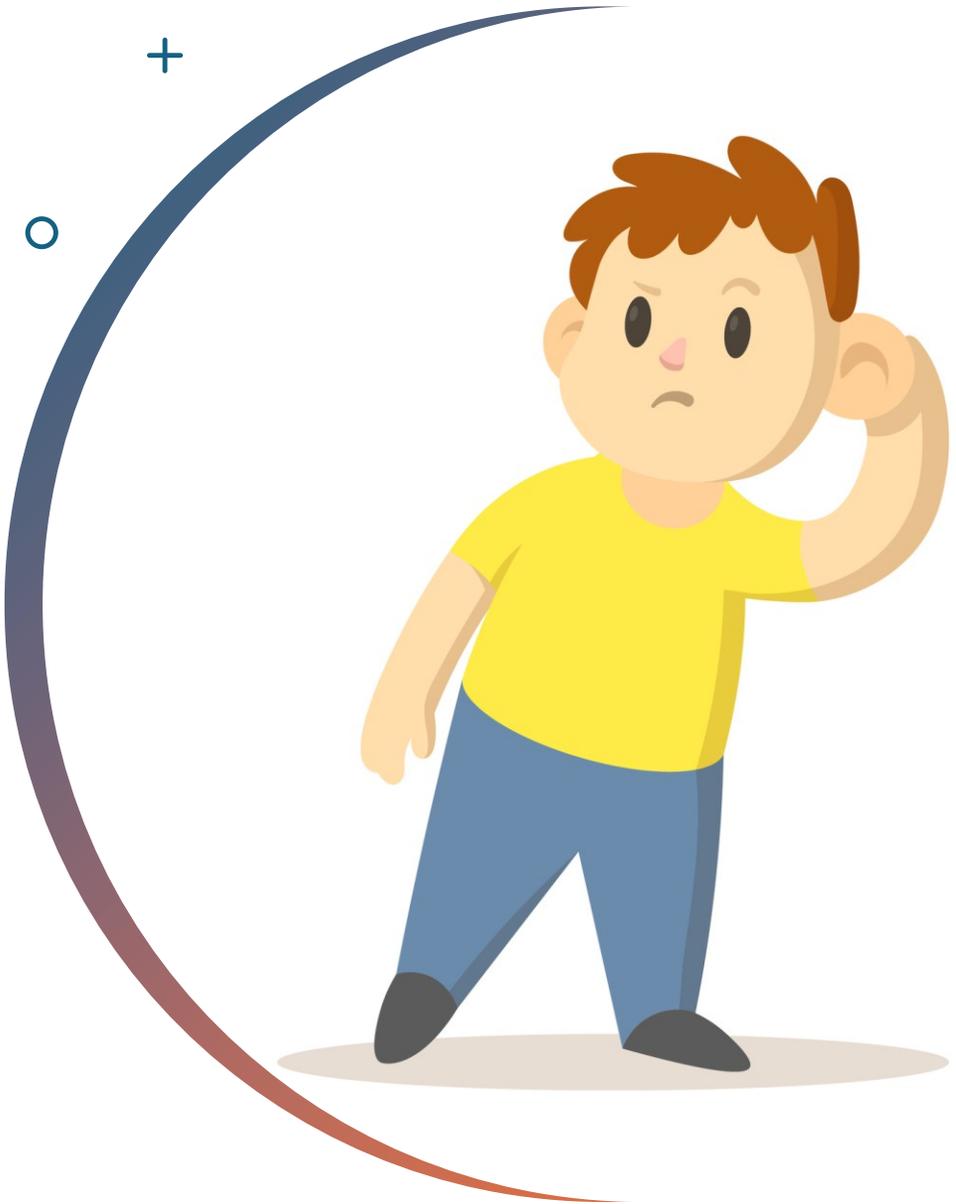




The Ears – Part 2

Hearing Loss Under the Microscope



Session Focus

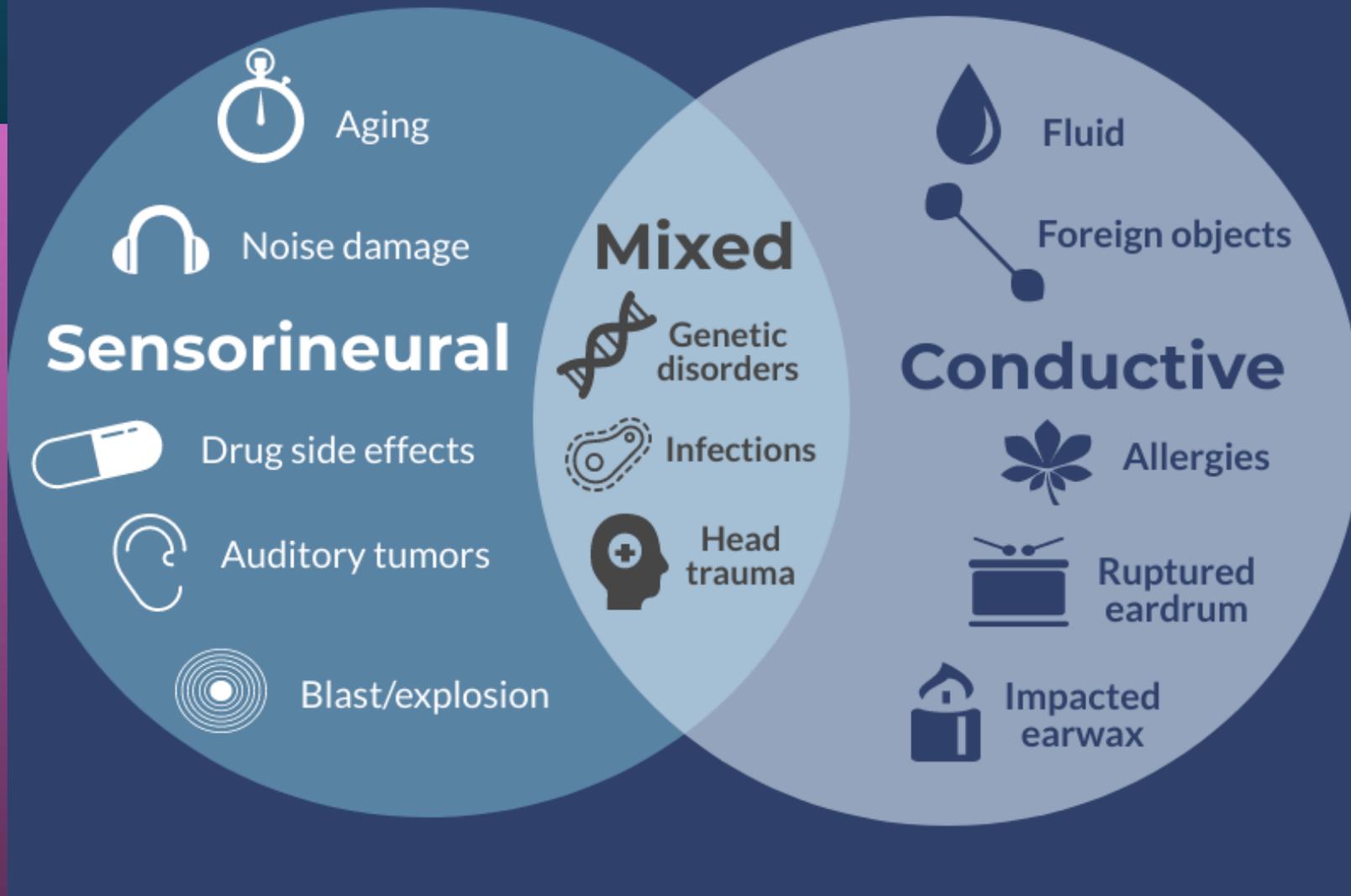
A practical, real-world look at what happens when the ears are **not functioning optimally**, have been **injured**, or have undergone **structural or inflammatory damage**—and how this affects hearing, balance, and sensory processing.



I. Hearing-Related Issues

Common patterns of hearing loss and what they reveal about where the problem originates

Types of hearing loss

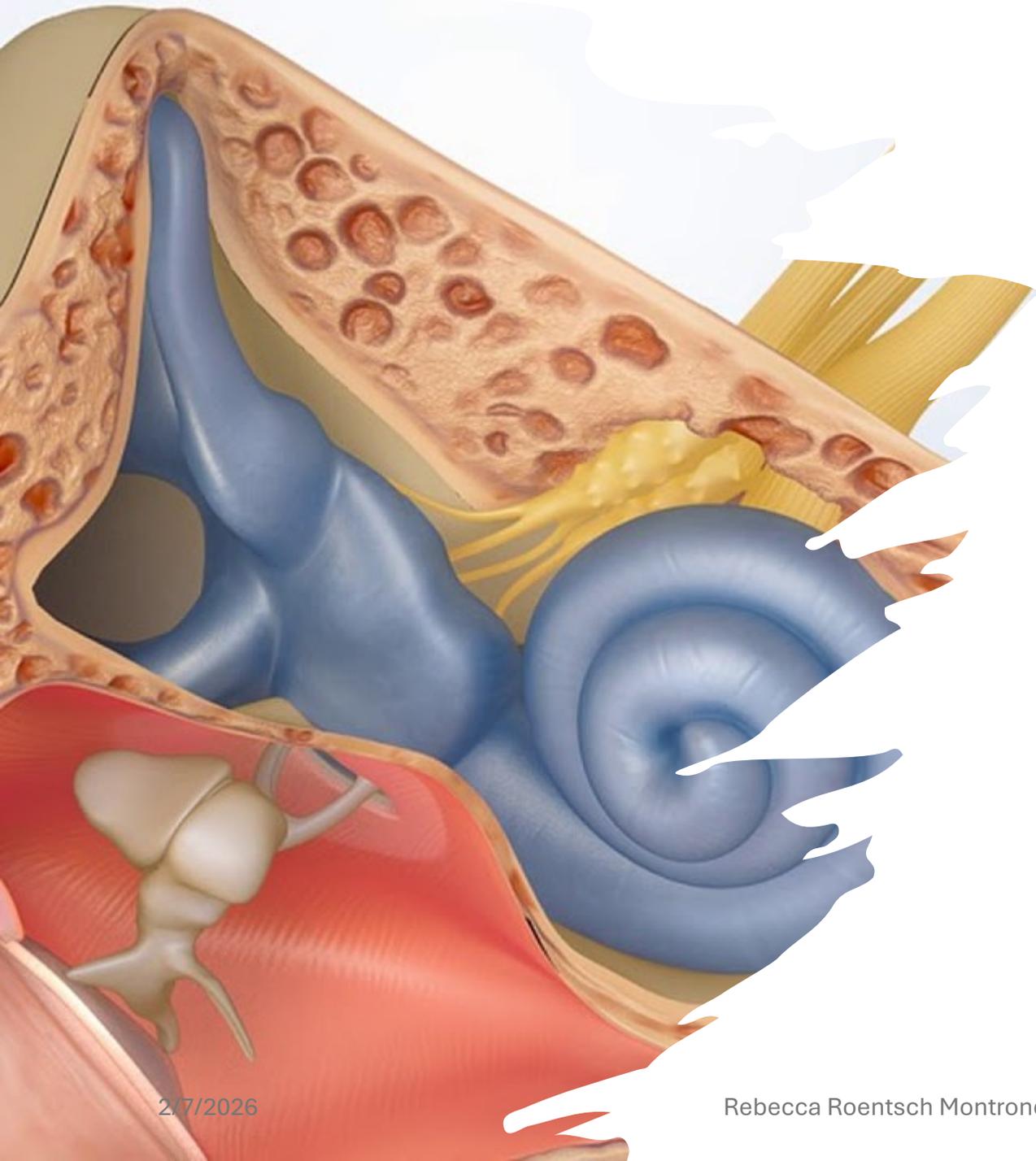




What is Sensorineural Hearing Loss?

1. Sensorineural Hearing Loss (SNHL)

- Damage to the **cochlea** or **auditory nerve**
- Often permanent
- Common causes: aging, noise exposure, viral injury, toxins, vascular compromise



Sensorineural Hearing Loss (SNHL)

What it is

- **Sensorineural hearing loss** occurs when sound is successfully delivered to the inner ear, but the **inner ear or auditory nerve cannot properly convert or transmit that sound to the brain.**

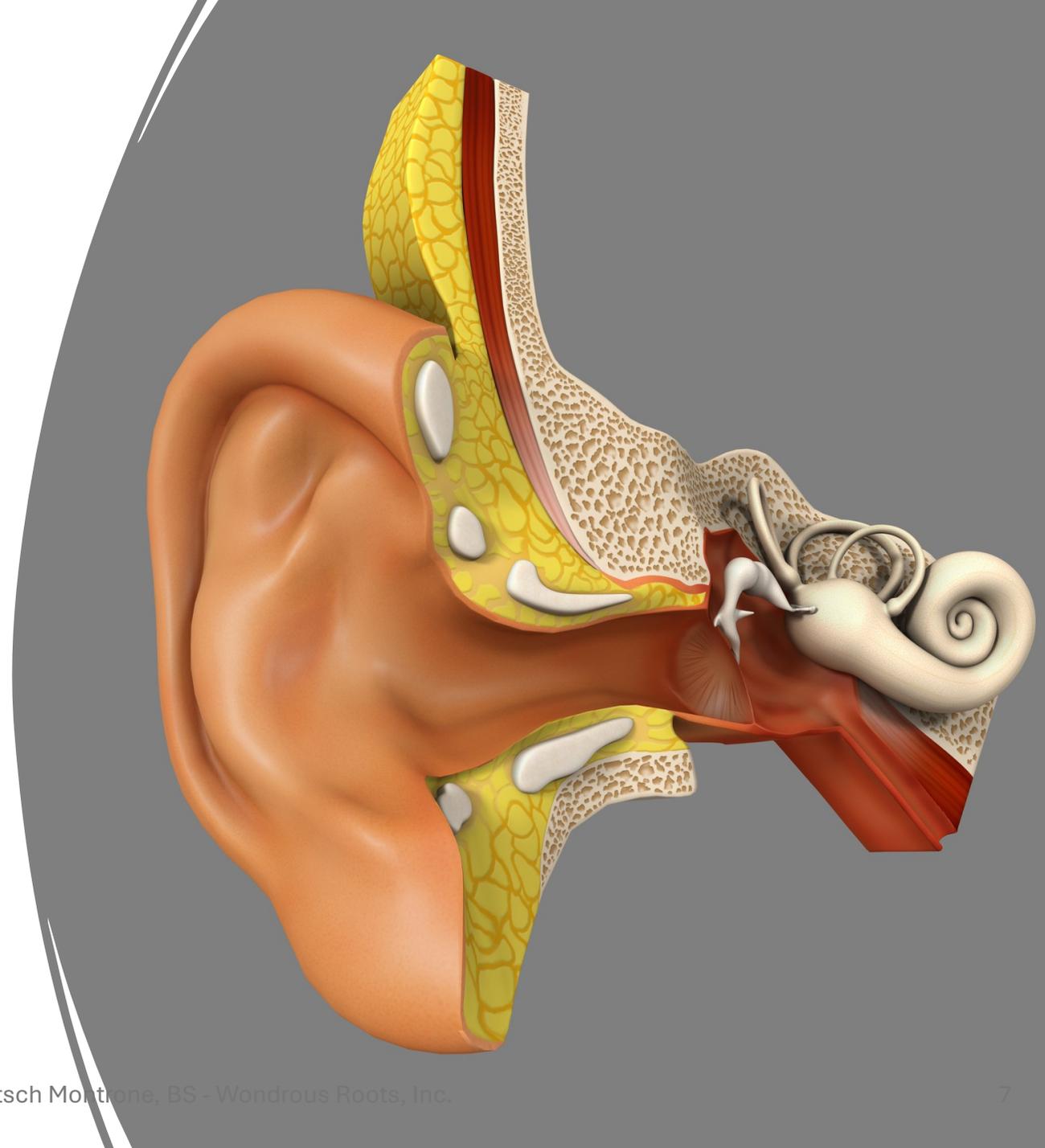
In other words: 👉 the *mechanics* may be working, but the *sensory or neural components* are impaired.

- This type of hearing loss involves damage to one or both of:
- The **cochlea**, especially the delicate **hair cells (cilia)**
- The **auditory (cochlear) nerve**, which carries sound information to the brain

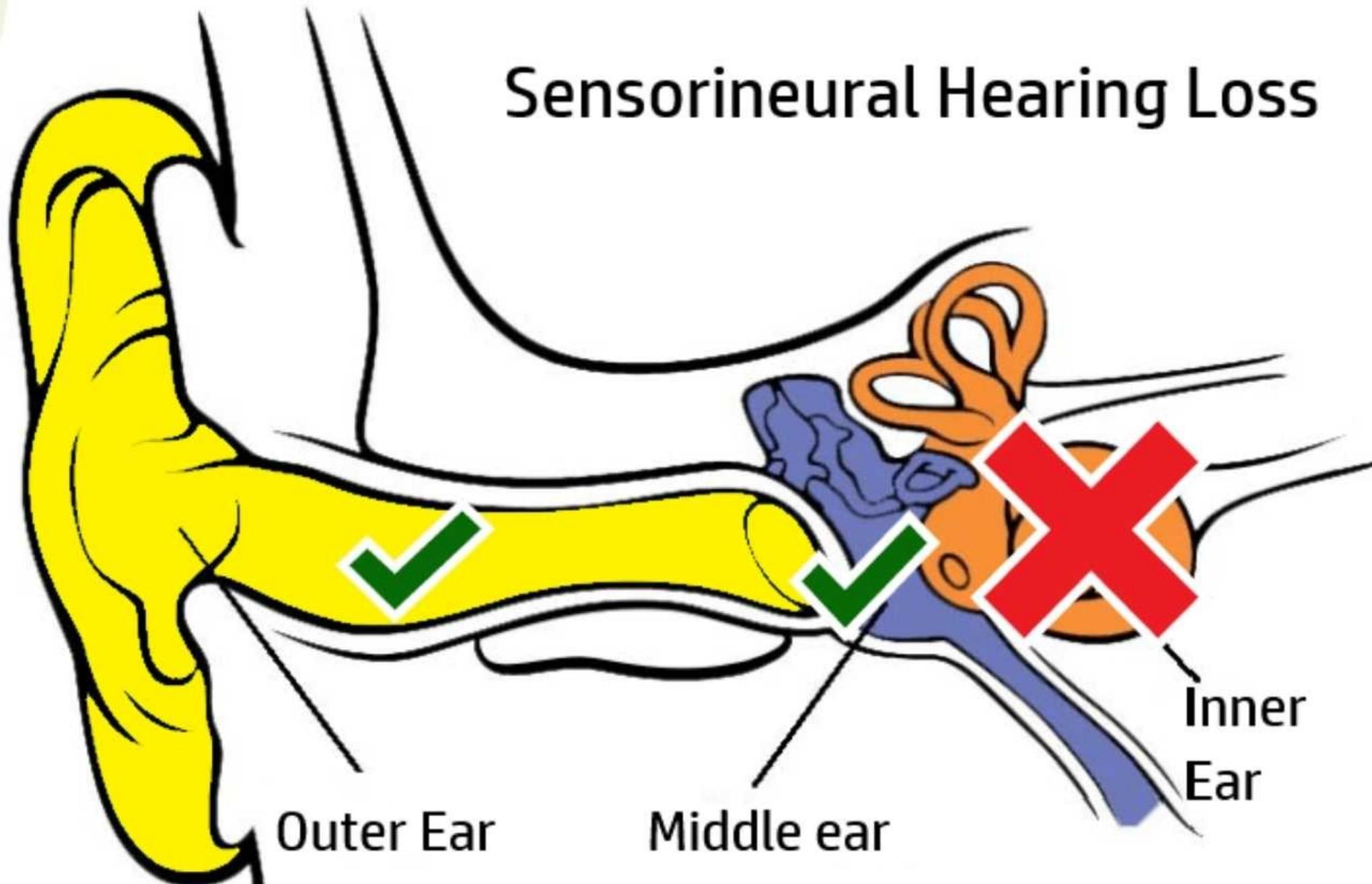
How hearing normally works (brief refresher)

- Sound waves enter the ear and are mechanically amplified
- Vibrations reach the cochlea
- **Hair cells bend in response to sound**, converting vibration into electrical signals
- The auditory nerve carries those signals to the brain for interpretation

In sensorineural loss, **steps 3 and/or 4 break down.**



Sensorineural Hearing Loss



How sensorineural hearing loss happens

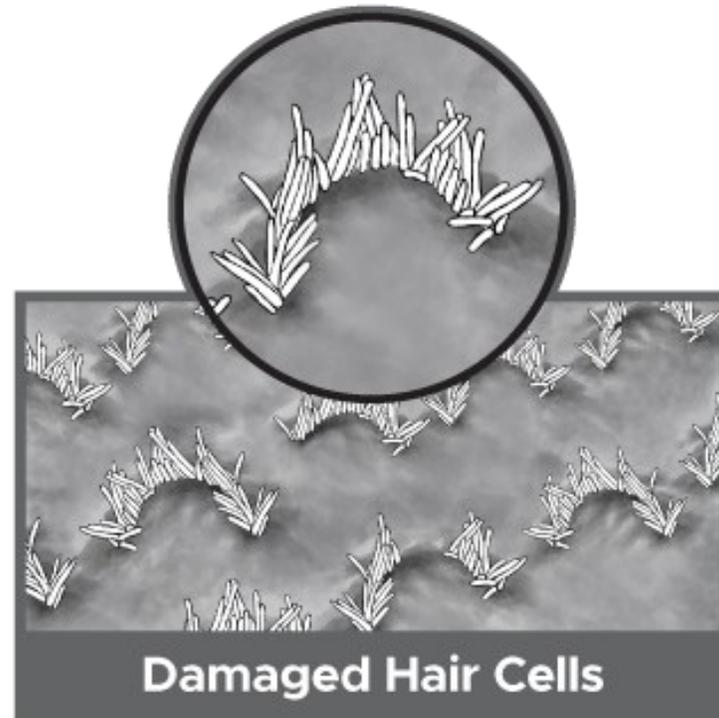
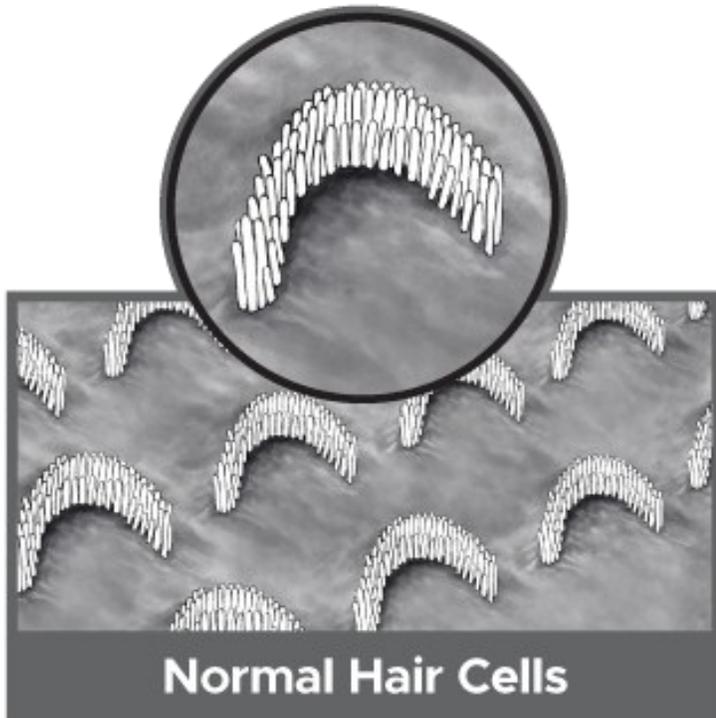
1. Hair cell damage (most common)

- The cochlea contains thousands of hair cells arranged by frequency:
 - **High-frequency hair cells** are especially fragile
 - Once damaged, **they do not regenerate**

Common causes:

- Aging (presbycusis)
- Chronic noise exposure
- Sudden acoustic trauma
- Viral infections (including COVID-19)
- Ototoxic medications or toxins
- Reduced blood flow or oxygen delivery





2. Auditory nerve damage

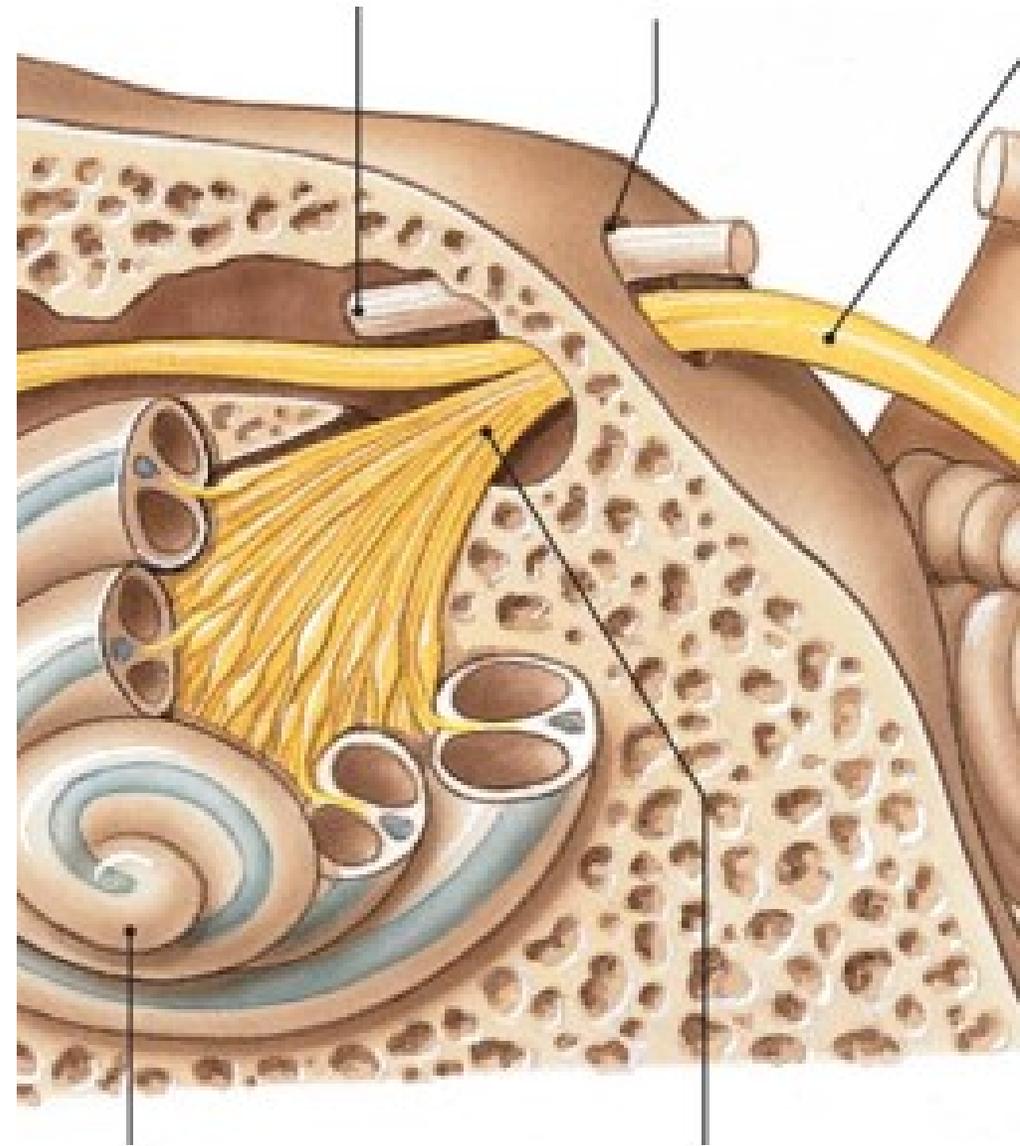
Less common, but often more complex.

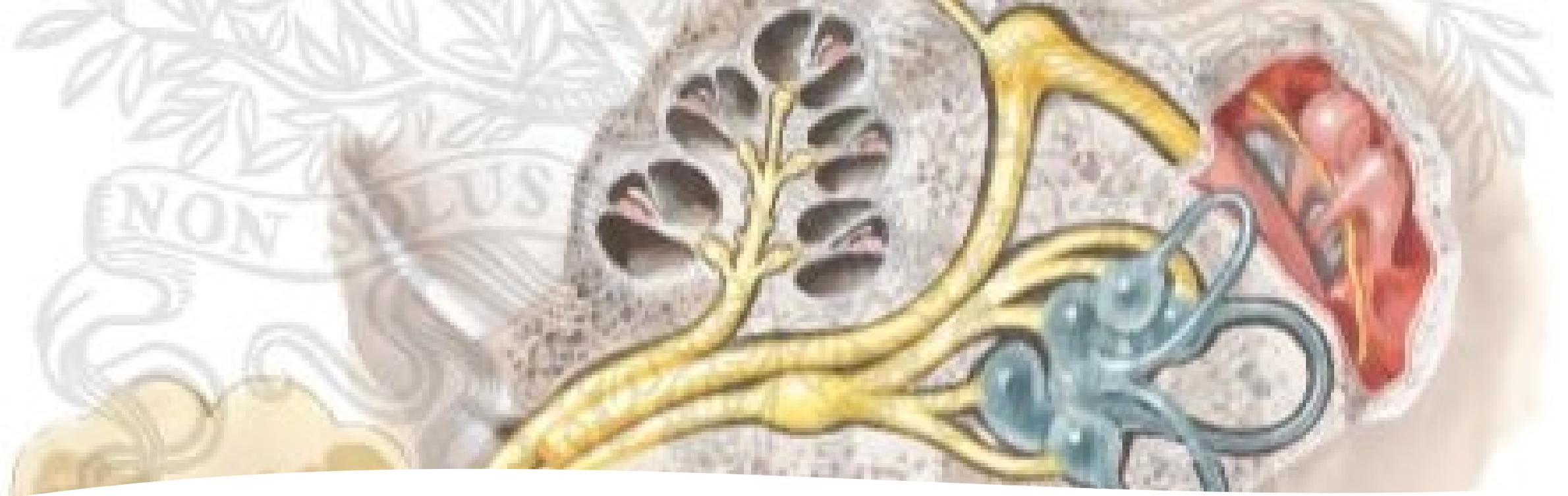
Causes include:

- Viral or inflammatory neuritis
- Autoimmune inner ear disease
- Tumors affecting the nerve
- Long-standing metabolic or vascular compromise
- Neurodegenerative processes

This can result in:

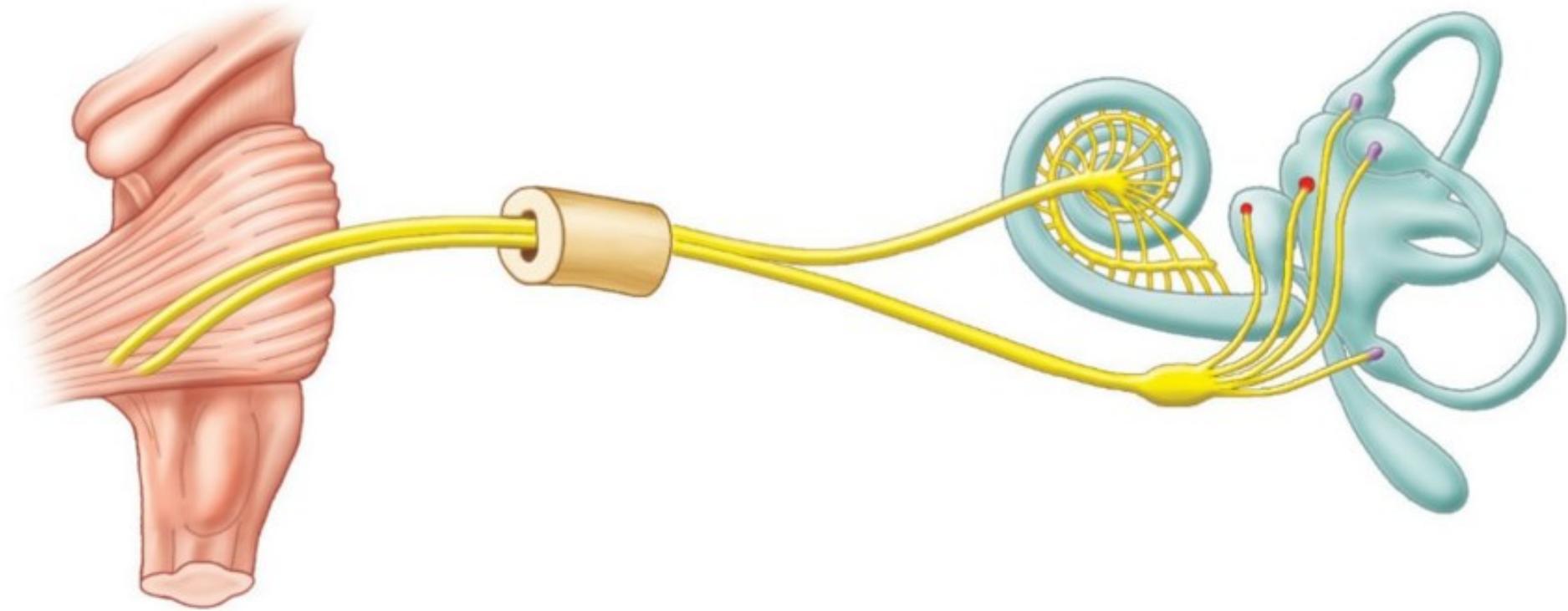
- Distorted sound
- Poor speech clarity
- Difficulty understanding speech in noisy environments





“The Auditory Nerve” – Cranial Nerve VIII

The term *auditory nerve* is commonly used as an umbrella term, but anatomically it refers to **Cranial Nerve VIII**, formally known as the **vestibulocochlear nerve**. This nerve is made up of two distinct branches: the **cochlear nerve**, which carries sound information from the cochlea to the brain, and the **vestibular nerve**, which carries balance and spatial orientation information from the inner ear. Although these functions are different, the two branches travel together, share anatomical space and blood supply, and enter the brain as a single nerve — which is why hearing and balance symptoms so often overlap.



What it feels like to the person

Sensorineural hearing loss is often not about loudness — it's about clarity.

Common complaints:

- *“I hear people talking, but I can't understand what they're saying.”*
- *“Everyone sounds like they're mumbling.”*
- *“Background noise makes everything worse.”*
- *“High-pitched voices are hardest to hear.”*
- Tinnitus is frequently present

This is why many people are told their hearing is “normal” — yet struggle daily.



Pattern and progression

Typical progression

- Often **gradual**, especially with age-related or noise-induced loss
- Commonly starts with **high frequencies**
- Speech discrimination worsens over time
- Can be **asymmetrical** (one ear worse than the other)

Sudden sensorineural hearing loss

- Can occur rapidly (hours to days)
- Often inflammatory, viral, or vascular
- Considered **time-sensitive**
- Outcome depends on:
 - Cause
 - Severity
 - Speed of intervention



Is sensorineural hearing loss reversible?

- Structural damage to hair cells or nerve tissue is generally permanent
- Early or functional components *may* improve if inflammation, circulation, or metabolic stress is addressed promptly
- Once hair cells are destroyed, the body does not replace them

Noise-induced hearing loss can be permanent & irreversible.



What is typically done about it

Conventional approaches

- **Hearing aids** to amplify and clarify sound
- **Cochlear implants** in severe cases
- Prompt medical treatment for sudden loss (e.g., steroids)

These approaches **do not restore damaged structures**, but they can improve function and quality of life.

2. Conductive Hearing Loss

- Impaired sound transmission through the **outer or middle ear**
- Often mechanical or inflammatory
- Frequently **reversible or improvable**



Conductive Hearing Loss

- An obstruction in the **outer and/or middle ear blocks the transmission of sound.**
- **Medical and/or surgical treatment may reduce or eliminate this type of hearing loss.**



Drawing taken from www.thehearingfix.com



Conductive Hearing Loss – What it is

Conductive hearing loss occurs when sound is **blocked, reduced, or distorted before it reaches the inner ear.**

In other words: 👉 the **sound signal doesn't get delivered efficiently**, even though the inner ear and auditory nerve may be perfectly capable of processing it.

Unlike sensorineural hearing loss (inner ear), this type of hearing loss involves problems in the:

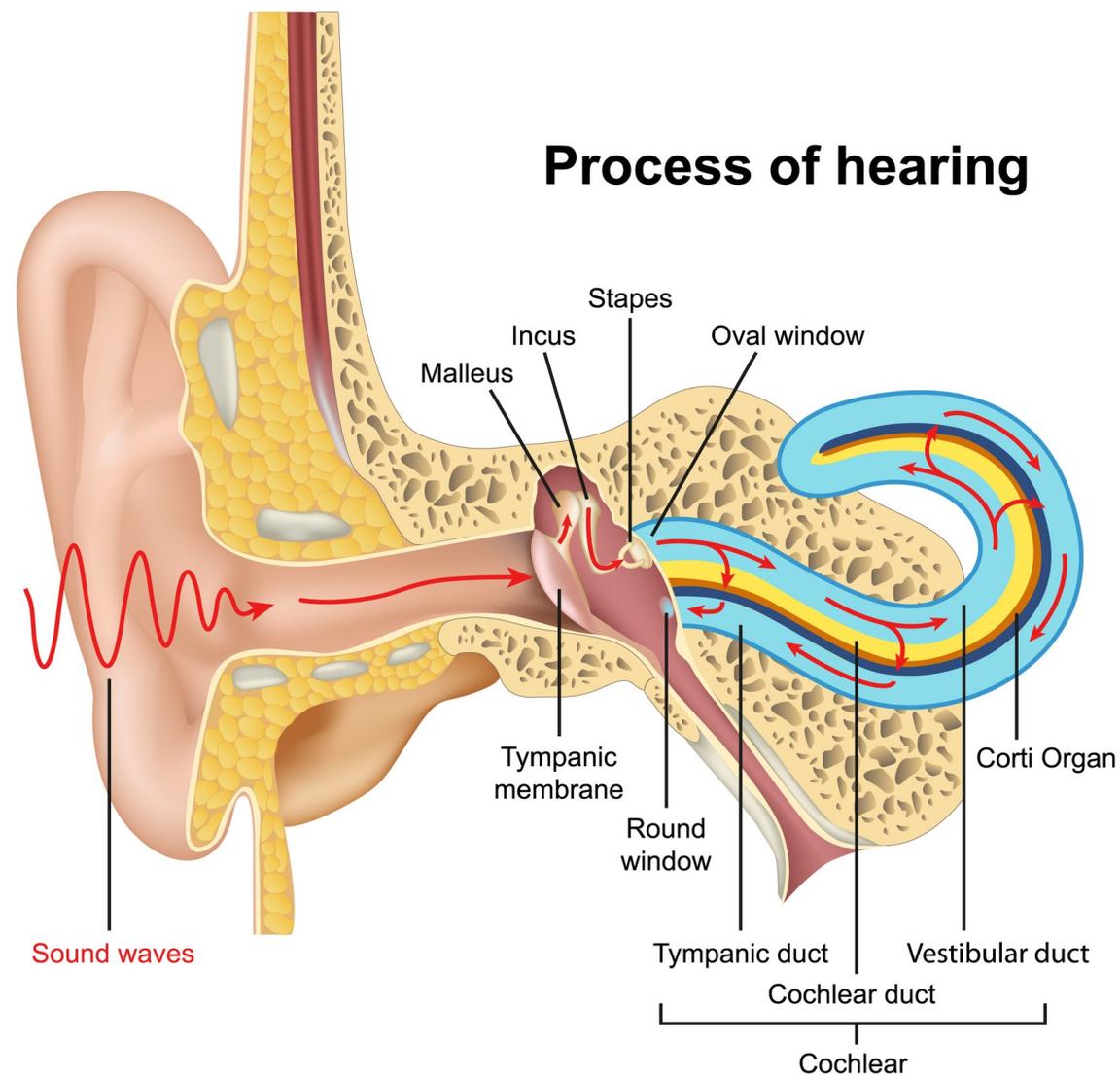
- **Outer ear** (ear canal)
- **Middle ear** (eardrum and ossicles)



How hearing normally works (quick context)

- Sound waves enter the ear canal
- Vibrations strike the eardrum
- The middle ear bones amplify the vibration
- Sound reaches the cochlea

In conductive hearing loss, **steps 1–3 are impaired.**

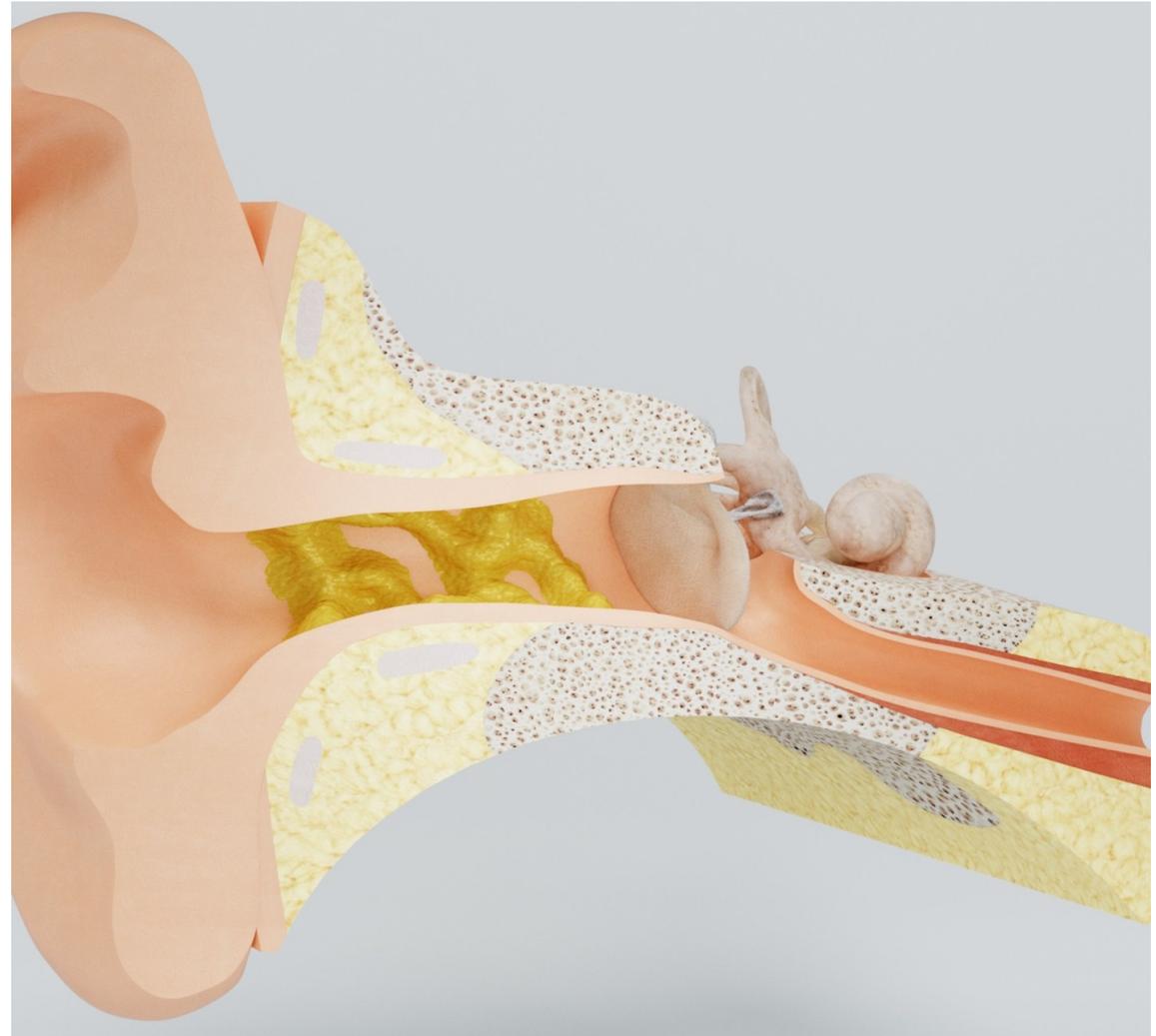


How conductive hearing loss happens

1. Outer ear causes

- Anything that physically interferes with sound entry or transmission:
- Earwax (cerumen) buildup
- Foreign bodies
- Swelling or narrowing of the ear canal
- External ear infections (otitis externa)
- Structural abnormalities

These are often **simple, mechanical problems**.





2. Middle ear causes

- Problems that interfere with vibration and amplification:
- Fluid behind the eardrum (common with colds, allergies, sinus issues)
- Eustachian tube dysfunction
- Middle ear infections (otitis media)
- Perforated eardrum
- Stiffening or damage to the ossicles
- Pressure imbalance

These are extremely common, especially in:

- Children
- People with chronic sinus or allergy issues
- Individuals prone to inflammation

How conductive hearing loss happens



What it feels like to the person

Conductive hearing loss is usually about volume, not clarity.

Common complaints:

- *“Everything sounds muffled or dull.”*
- *“It feels like my ear is plugged.”*
- *“I hear better when people speak loudly.”*
- *“My own voice sounds louder in my head.”*
- Sensation of pressure or fullness

Speech clarity is often preserved — it’s just *quieter*.



Pattern and progression

Typical course

- Often **sudden or fluctuating**
- May change with:
 - Position
 - Swallowing
 - Yawning
 - Changes in pressure or congestion

Frequently **temporary or reversible**

Chronic conductive loss

- Can occur with repeated infections, scarring, or long-standing inflammation
- Structural changes may accumulate over time
- Still often more modifiable than sensorineural loss



Is conductive hearing loss reversible?

Yes — very often

- Many causes are **mechanical or inflammatory**, not destructive
- Once obstruction, fluid, or pressure imbalance is corrected, hearing often improves significantly or fully

This is why identifying *where* the problem lies matters so much.

What is typically done about it

Conventional approaches

- Removal of earwax or obstructions
- Treating infections or inflammation
- Addressing Eustachian tube dysfunction
- Pressure equalization strategies
- Surgical repair in select cases

These approaches aim to **restore sound transmission**, not compensate for lost sensory cells.



Supportive and integrative considerations

Focus areas may include:

- Reducing chronic inflammation
- Supporting sinus and upper airway health
- Improving pressure regulation
- Addressing allergic triggers
- Supporting tissue healing and circulation

The goal is often **restoration of normal mechanics**, not adaptation to loss.



Sensorineural vs. Conductive Hearing Loss

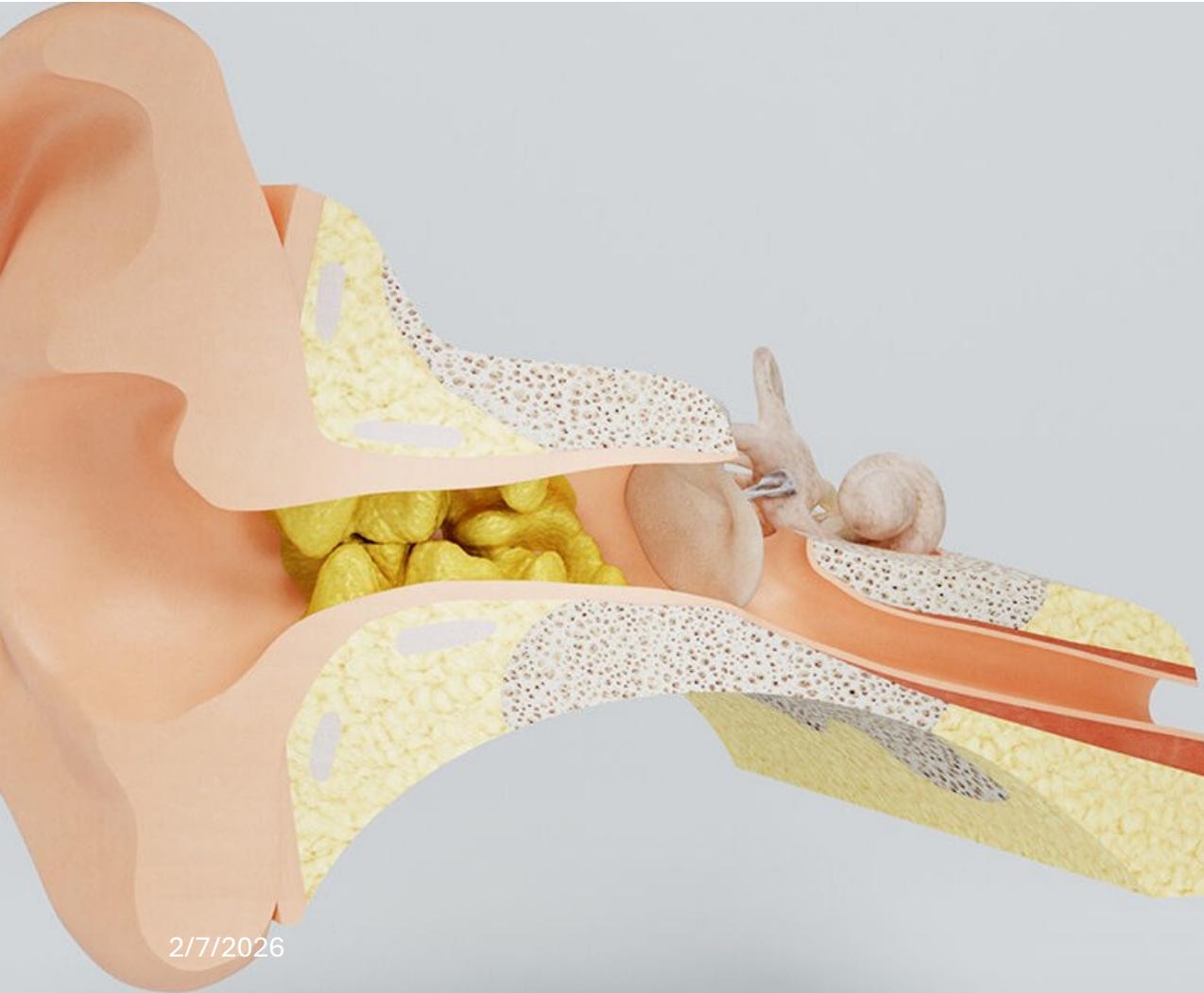
Conductive hearing loss is a problem of **sound delivery**.
Sensorineural hearing loss is a problem of **sound processing**.

Why this distinction matters clinically

- Conductive loss is often **treatable and reversible**
- Sensorineural loss is often **permanent but manageable**
- Mixed hearing loss requires recognizing **both components**
- Mislabeling the type can lead to unnecessary fear — or false hope



A Brief Detour: Earwax (Cerumen)



I completely forgot about this in my first session on the ears – structure, anatomy, and function.

What earwax is

- **Earwax**, medically called **cerumen**, is a natural substance produced by glands in the **outer ear canal**. It's a mixture of:
 - Fatty secretions
 - Sweat-like secretions
 - Shed skin cells

Despite its bad reputation, earwax is **normal, protective, and necessary**.

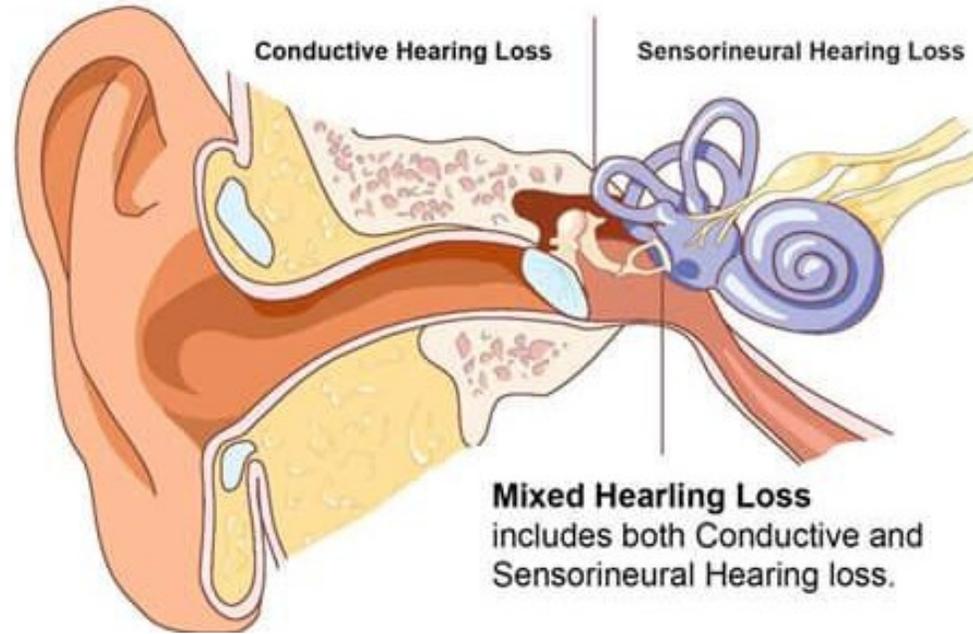
What earwax does (its job)

Earwax serves several important functions:

- **Protects** the ear canal from dust, debris, and insects
- **Traps particles** before they reach the eardrum
- **Provides antimicrobial protection** against bacteria and fungi
- **Moisturizes** the ear canal, preventing dryness and irritation

In healthy ears, earwax **naturally migrates outward** and falls away on its own.





- Combination of conductive and sensorineural components
- Requires careful differentiation for appropriate support

3. Mixed Hearing Loss

4. High-Frequency Hearing Loss

- Common early pattern
- Often age-related or noise-induced
- Impacts speech clarity more than volume

High-Frequency Hearing Loss



Chart Source: Hearing Like Me



4. High-Frequency Hearing Loss

What it is

- **High-frequency hearing loss** refers to reduced ability to hear **higher-pitched sounds**, typically in the range that includes:
 - Consonants (S, F, T, K, SH, CH)
 - Women’s and children’s voices
 - Environmental detail sounds (birds, beeps, rustling)

Crucially, **lower-frequency hearing may remain relatively intact**, which is why people often say:

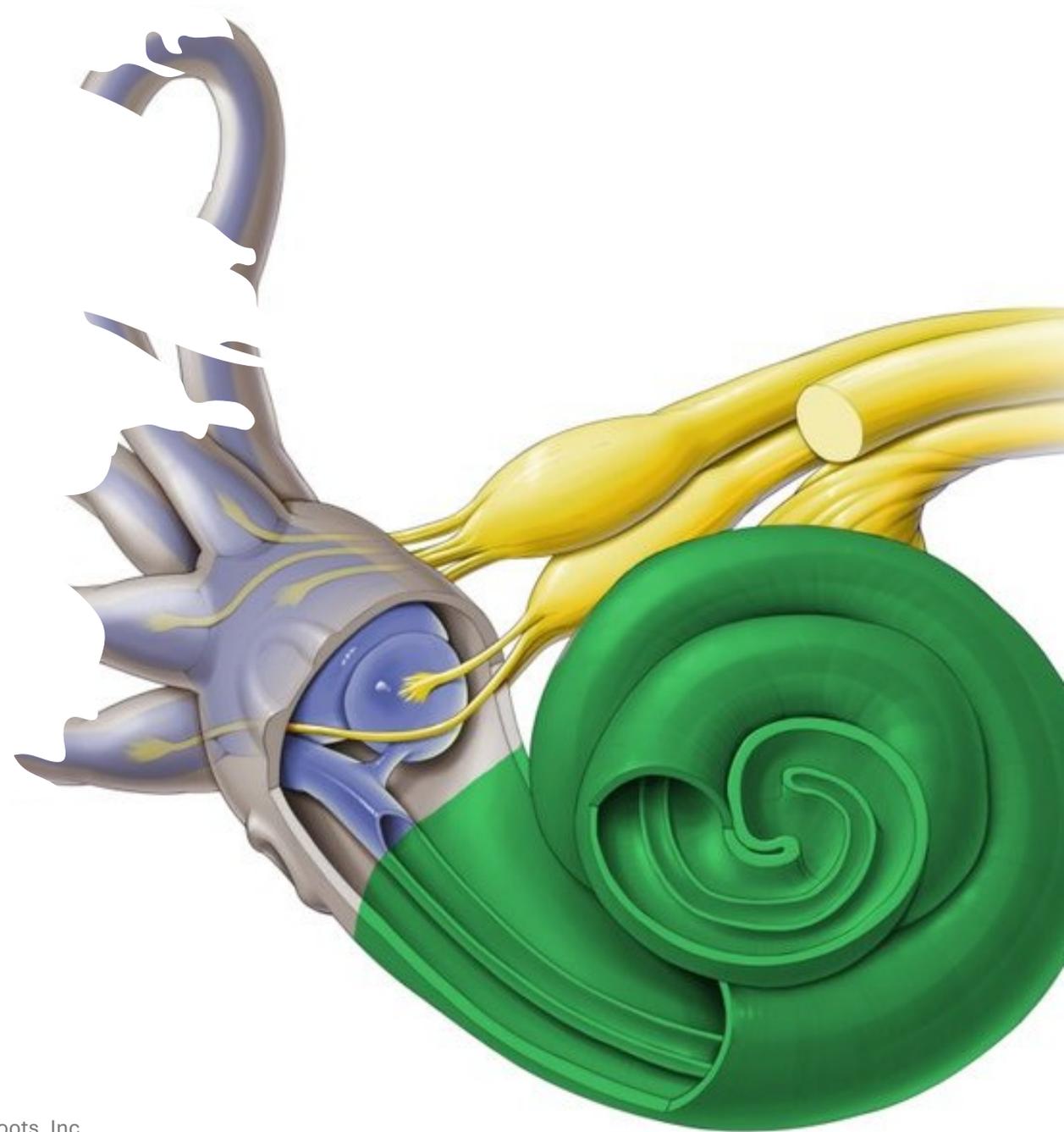
“I can hear you — I just can’t understand you.”

Where it occurs anatomically

High-frequency hearing loss is almost always a **sensorineural issue** involving the **cochlea**.

- The cochlea is **tonotopically organized**
- **High-frequency sounds are detected at the base of the cochlea**
- These hair cells are:
 - The most fragile
 - The most metabolically active
 - The most vulnerable to damage

*This is why high frequencies are usually affected **first**.*



How high-frequency hearing loss happens

1. Aging (presbycusis)

- Gradual, cumulative hair cell wear
- Begins subtly, often decades before it's noticed
- Nearly universal with age, but **rate varies widely**

2. Noise exposure

- Chronic exposure (music, machinery, earbuds)
- Sudden acoustic trauma (explosions, gunfire)
- Often bilateral but may be asymmetric

Importantly:

You don't need ear-splitting noise — moderate noise over time is enough.



3. Inflammation, vascular, or metabolic stress

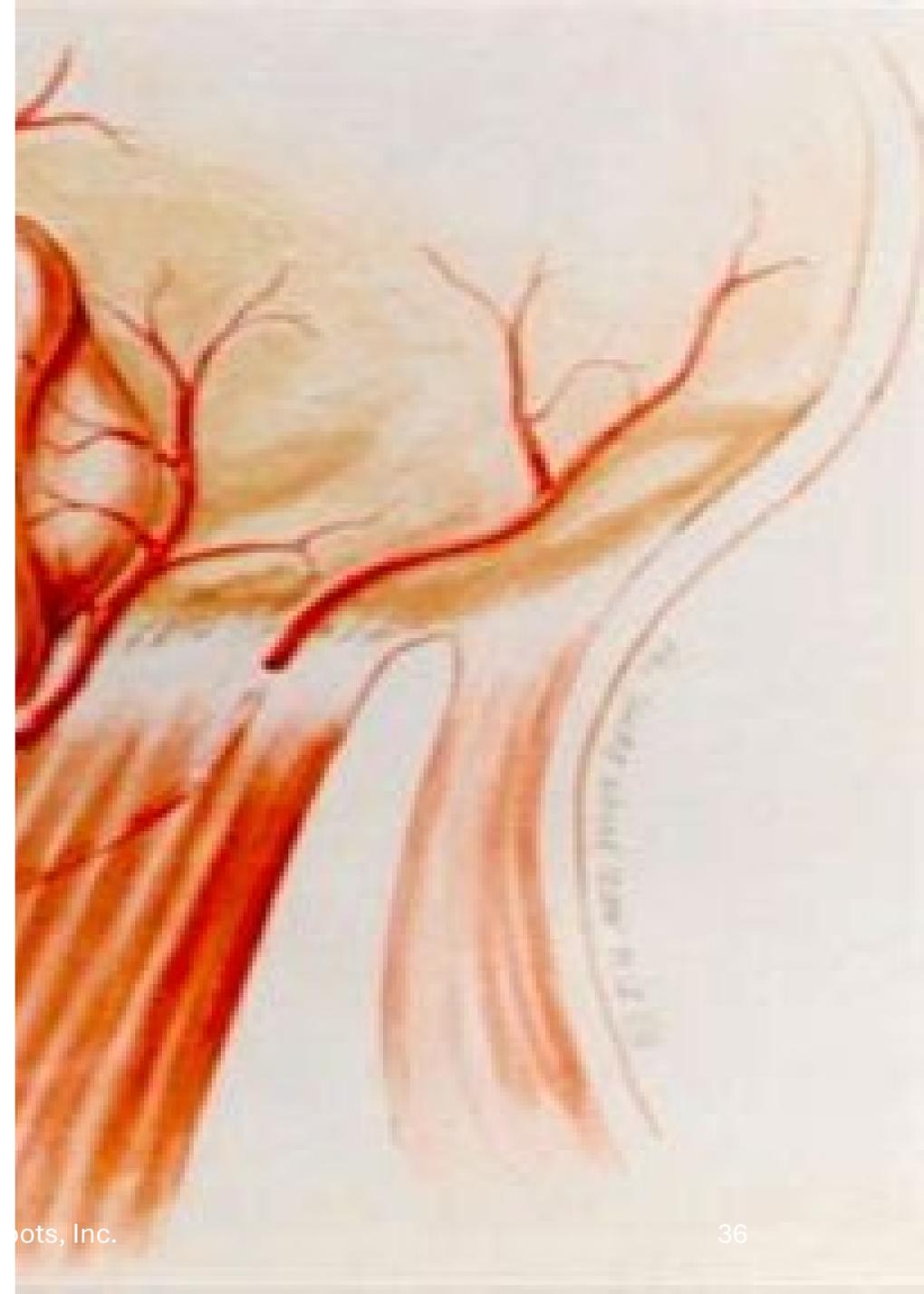
- Reduced blood flow or oxygen delivery
- Chronic inflammation
- Mitochondrial stress in hair cells
- Viral injury

This is where high-frequency loss overlaps with:

- COVID-related hearing changes
- Autoimmune processes
- Circulatory compromise

4. Ototoxic exposure

- Certain medications
- Environmental toxins
- Effects may be subtle at first



What it Feels Like to the Person

Common complaints:

- *“People sound like they’re mumbling.”*
- *“I hear vowels but miss consonants.”*
- *“I can hear you better when I see your face.”*
- *“Background noise makes everything worse.”*
- *“Women’s voices are harder to hear than men’s.”*

This explains why:

- Volume doesn’t fix the problem
- Repeating louder doesn’t help much
- Clarity, not loudness, is the issue





Why speech understanding is so affected

High-frequency sounds carry **speech detail**, not volume.

- Vowels = low frequency (loud, easy to hear)
- Consonants = high frequency (quiet, critical for meaning)

So:

- “cat,” “cap,” and “can” may all sound the same
- Sentences lose precision
- Listening becomes mentally exhausting

This often leads to:

- Social withdrawal
- Listening fatigue
- Irritability
- Cognitive overload

Pattern & Progression

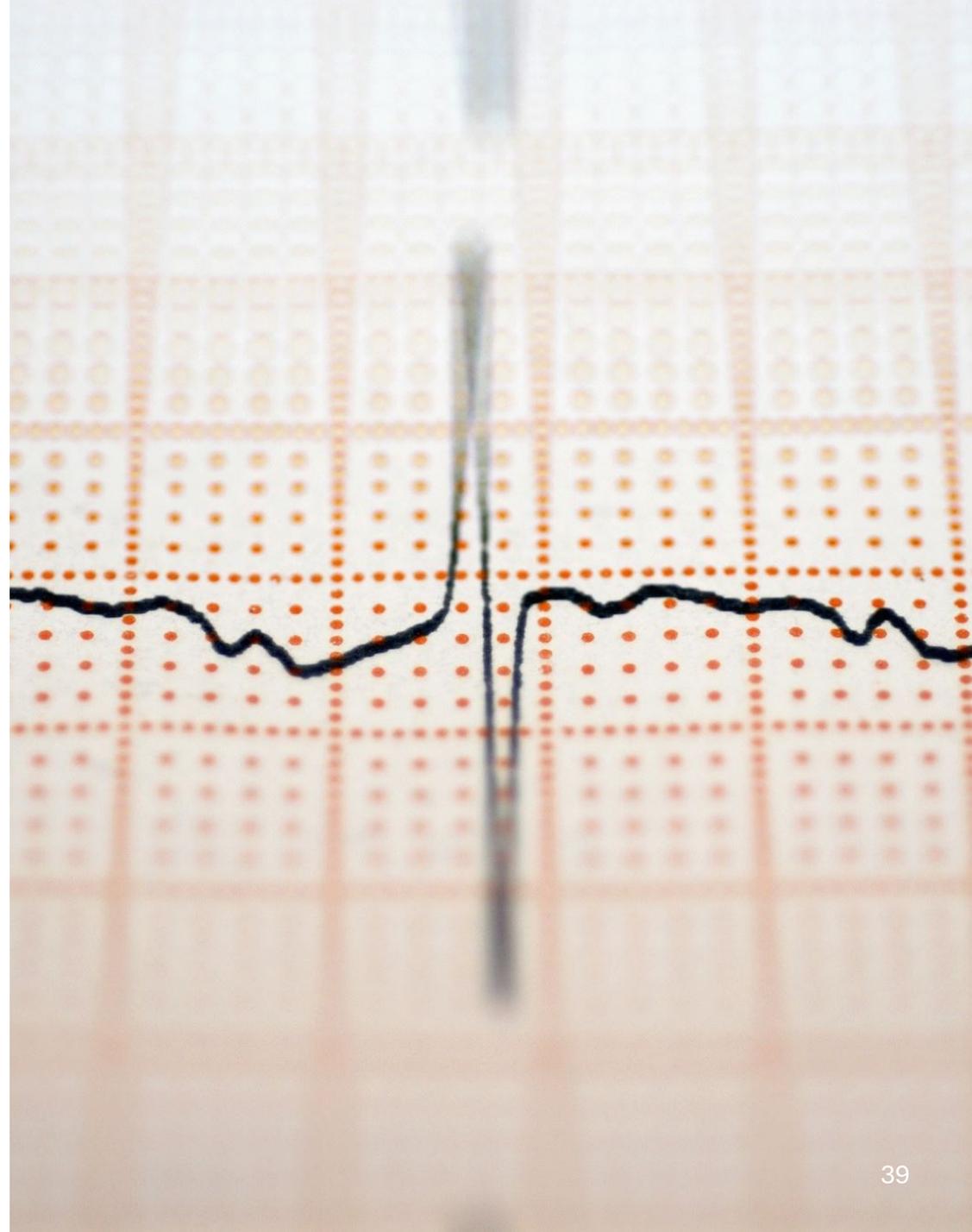
Typical progression

- Begins subtly
- Often unnoticed for years
- Worsens gradually
- May be symmetrical or asymmetrical

Important nuance

- High-frequency loss may:
- Plateau for long periods
- Progress in steps
- Worsen faster with continued noise or inflammation

*It is often the **gateway** to broader sensorineural hearing loss.*



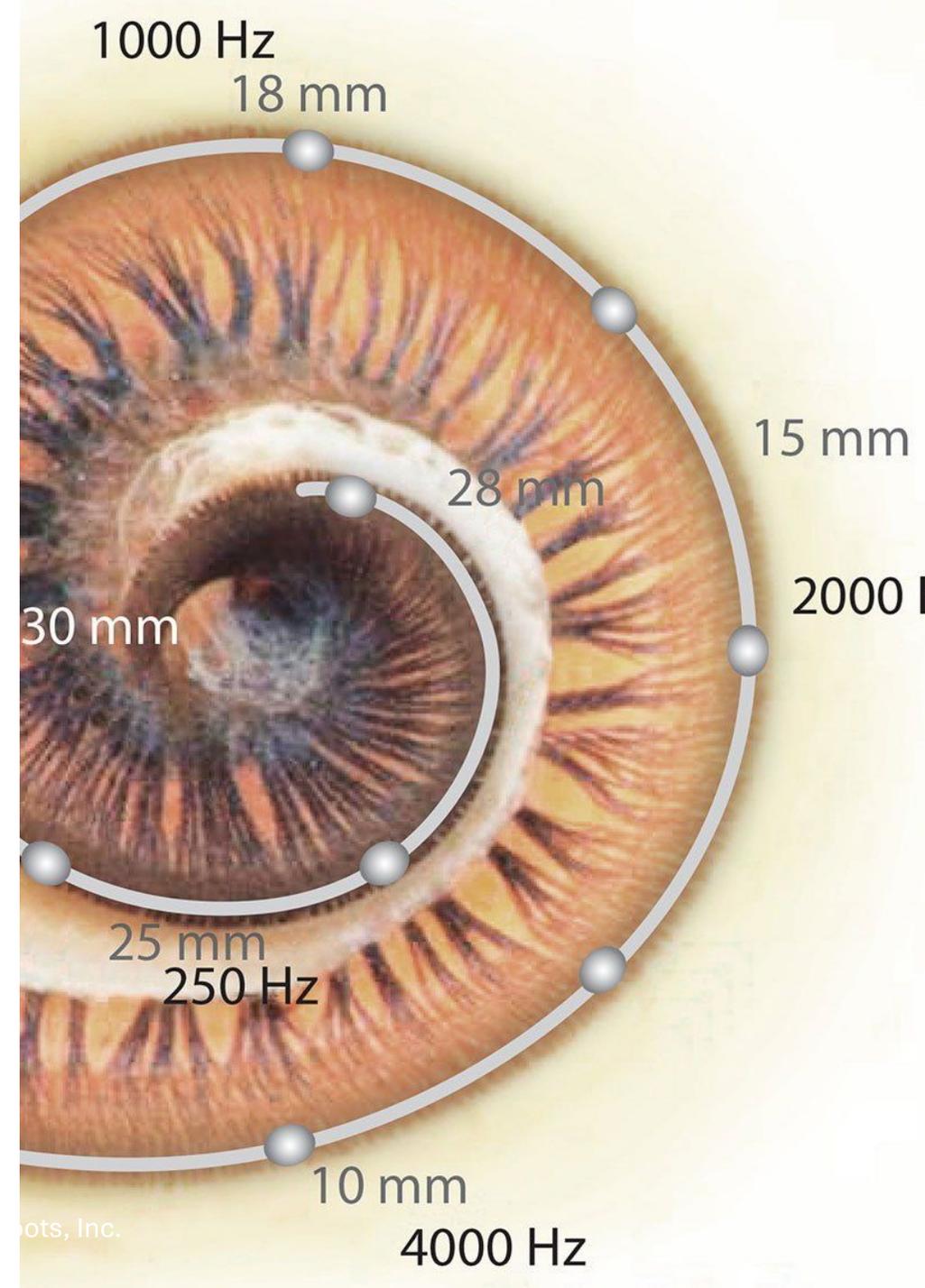
Is high-frequency hearing loss reversible?

Here's where clarity matters:

- **Damage to cochlear hair cells is permanent**
- Early functional stress *may* be modifiable
- Once hair cells are destroyed, they do not regenerate

So, the goal becomes:

***Preserve remaining hair cells
and optimize brain adaptation***



Why High-Frequency Hearing Loss Can be Missed

- Standard hearing tests may appear “mostly normal”
- People compensate visually and cognitively
- Symptoms are blamed on:
 - Attention
 - Memory
 - Aging
 - “People not speaking clearly”

This makes proper diagnosis incredibly important.



How it Typically Addressed

Conventional approaches

- Hearing aids designed to:
 - Amplify high frequencies selectively
 - Improve speech clarity rather than volume
- Early intervention is key — waiting makes adaptation harder

5. Sudden Hearing Loss

Sudden Sensorineural Hearing Loss (SSNHL)

- Rapid decline in hearing
- Occurs over hours to a few days
- Most often affects one ear
- Involves the inner ear (cochlea) or auditory nerve



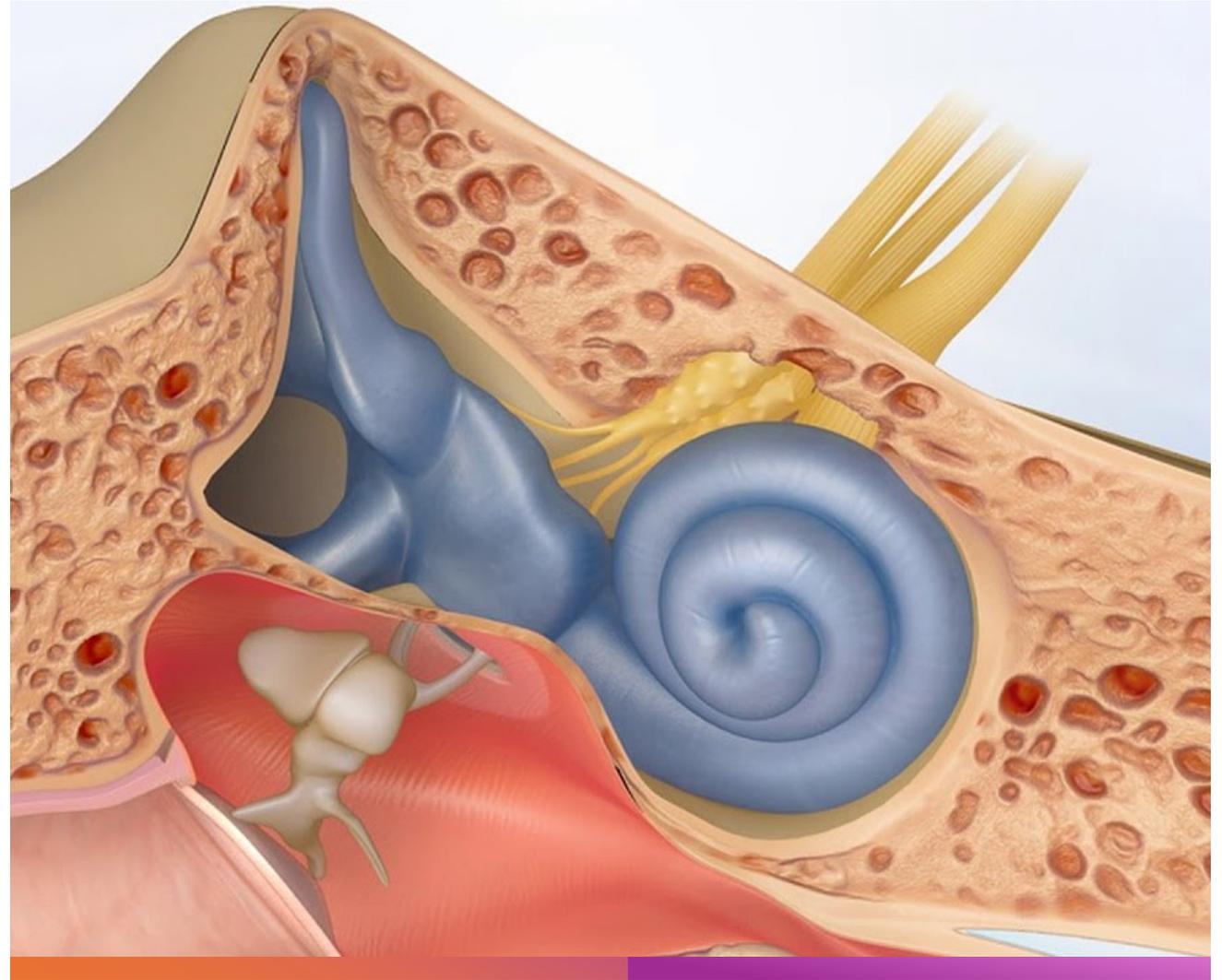
Key Features



- Abrupt onset
- Noticeable change in hearing
- Often accompanied by:
 - Tinnitus
 - Ear fullness or pressure
 - Possible dizziness or imbalance
- Not caused by:
 - Earwax
 - Middle ear fluid
 - Mechanical blockage

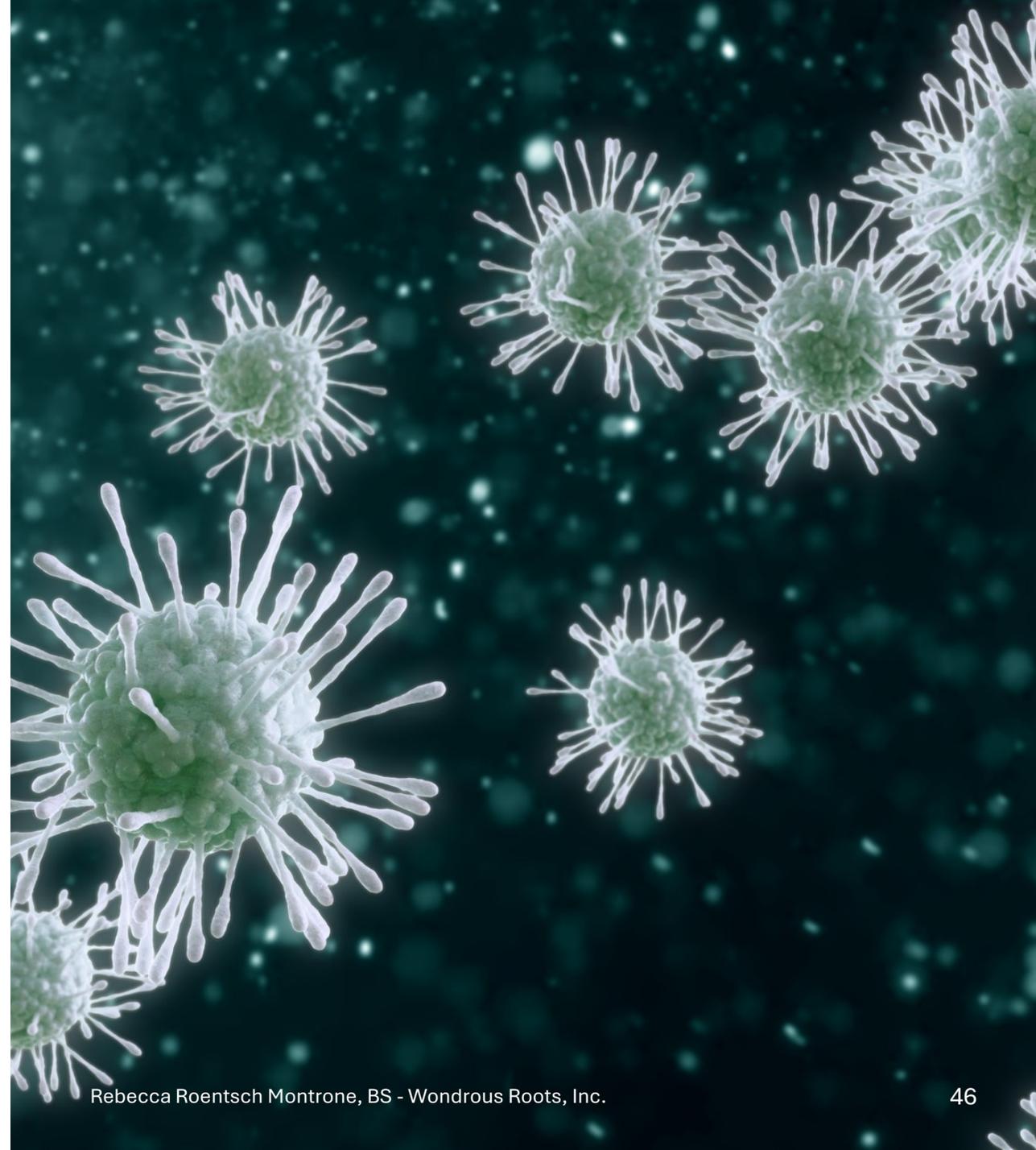
Anatomical Location of Injury

- Cochlear hair cells
- Auditory (cochlear) nerve
- Microvascular supply to the inner ear



Common Mechanisms

- Viral infection
- Post-viral inflammatory response
- Microvascular compromise
- Autoimmune inner ear disease
- Metabolic or oxidative stress
- Idiopathic (unknown cause)





Pathophysiology

- Inflammatory cascade affecting cochlear structures
- Reduced blood flow to metabolically active hair cells
- Direct or indirect injury to sensory cells
- Damage to neural signal transmission



Reversibility Factors

Recovery more likely if:

- Primary injury is inflammatory
- Hair cells are stressed but structurally intact
- Blood flow is restored quickly

Permanent loss more likely if:

- Hair cells are destroyed
- Neural structures are damaged
- Ischemic injury results in cell death
- Human cochlear hair cells do not regenerate.

New Study Shows Link Between COVID-19, Hearing Loss & Tinnitus



Clinical Case: COVID-19–Associated Sudden Hearing Loss

Sudden Hearing Loss Waves: The Effect of COVID-19 Infection and Vaccination on the Inner Ear

Summary

Sudden sensorineural hearing loss (SSNHL) has emerged as a potential complication of COVID-19 infection and vaccination. Various mechanisms by which the SARS-CoV-2 virus can cause hearing loss have been reported, including direct viral invasion, neuroinflammation, blood flow disturbances, and immune-mediated response. However, the temporal relationship between COVID-19 infection and SSNHL remains unclear, with mixed findings and conflicting results reported in different studies. Similarly, while anecdotal reports have linked COVID-19 vaccination to SSNHL, evidence remains scarce. Establishing a correlation between COVID-19 vaccines and SSNHL implies a complex and multifactorial pathogenesis involving interactions between the immune system and the body's stress response. Nevertheless, it is important to consider the overwhelming evidence of the vaccines' safety and efficacy in limiting the spread of the disease and remains the primordial tool in reducing death. Also, see: [COVID-19 and hearing loss—A narrative review](#)

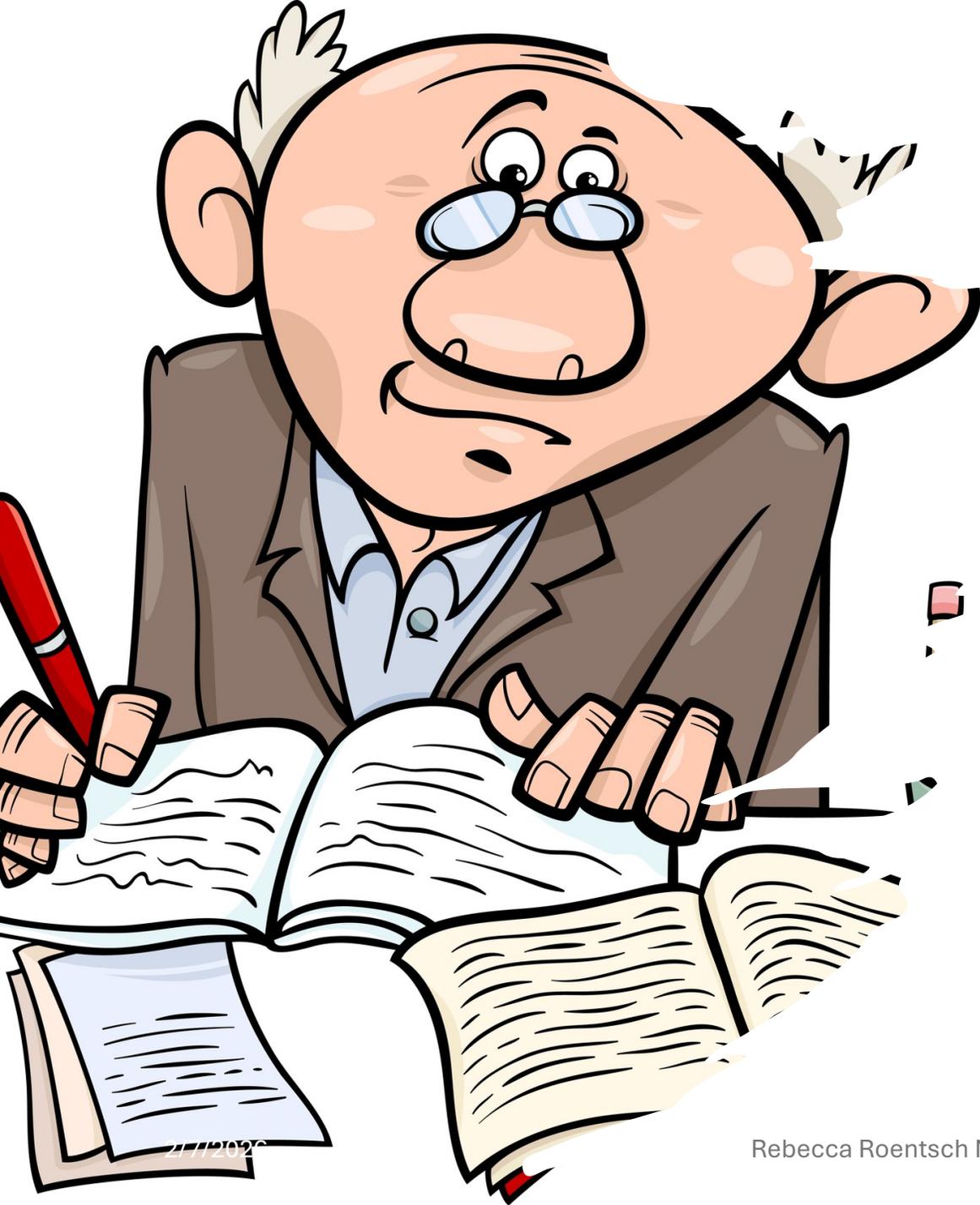
Clinical Presentation

70-year-old woman in otherwise good health presents with:

- Previously normal baseline hearing
- History of COVID-19 infection during which this occurred
- Subsequent high-frequency hearing loss
- Sound-induced pain
- Distorted sound perception
- Poor or no benefit from hearing aids
- Documented cochlear injury
- High-frequency hair cell loss
- Sound-evoked pain (sensory gain dysregulation)

*Pattern consistent with **sudden sensorineural hearing loss**, not conductive pathology.*





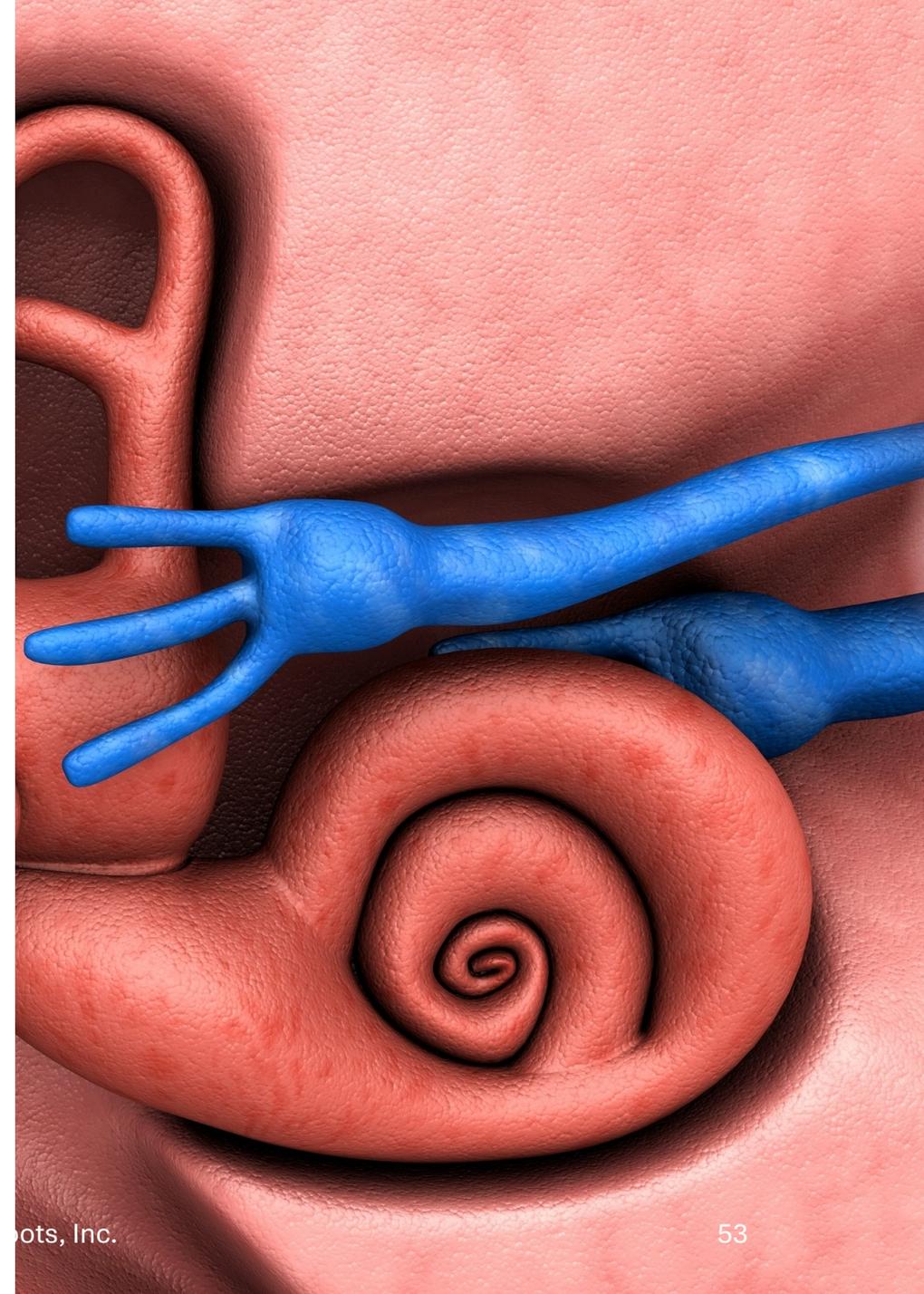
From my notes...

“Susan had inner ear disruption from Covid to the point of losing about 50% hearing (July of 22); audiology studies have shown inner ear damage irreparable, hearing aids don't work; the high range is the worst - the most affected - pain associated with high-pitch sounds (which is why the hearing aids don't work - it's not a "hearing thing." She thinks since doing the 7-day course of nicotine patches she might sense that there has been an occasional auditory sound "almost like tinnitus" (oh great) that wasn't present before that comes and goes and not that frequent.”

Anatomical Pattern

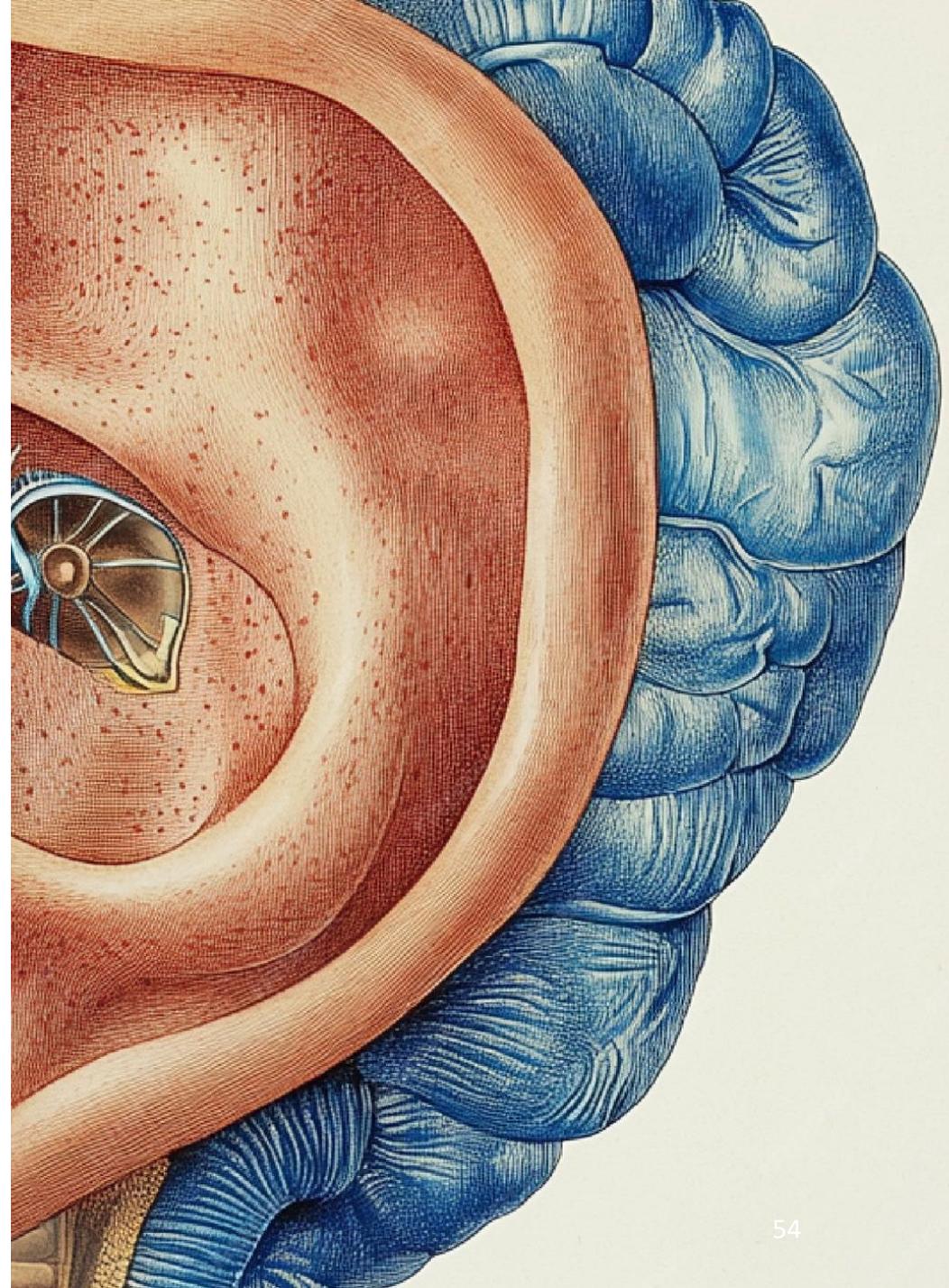
- High-frequency loss
- Basal turn of cochlea most affected
- No middle ear involvement
- No mechanical obstruction

Signature pattern of **inner ear (cochlear) injury**

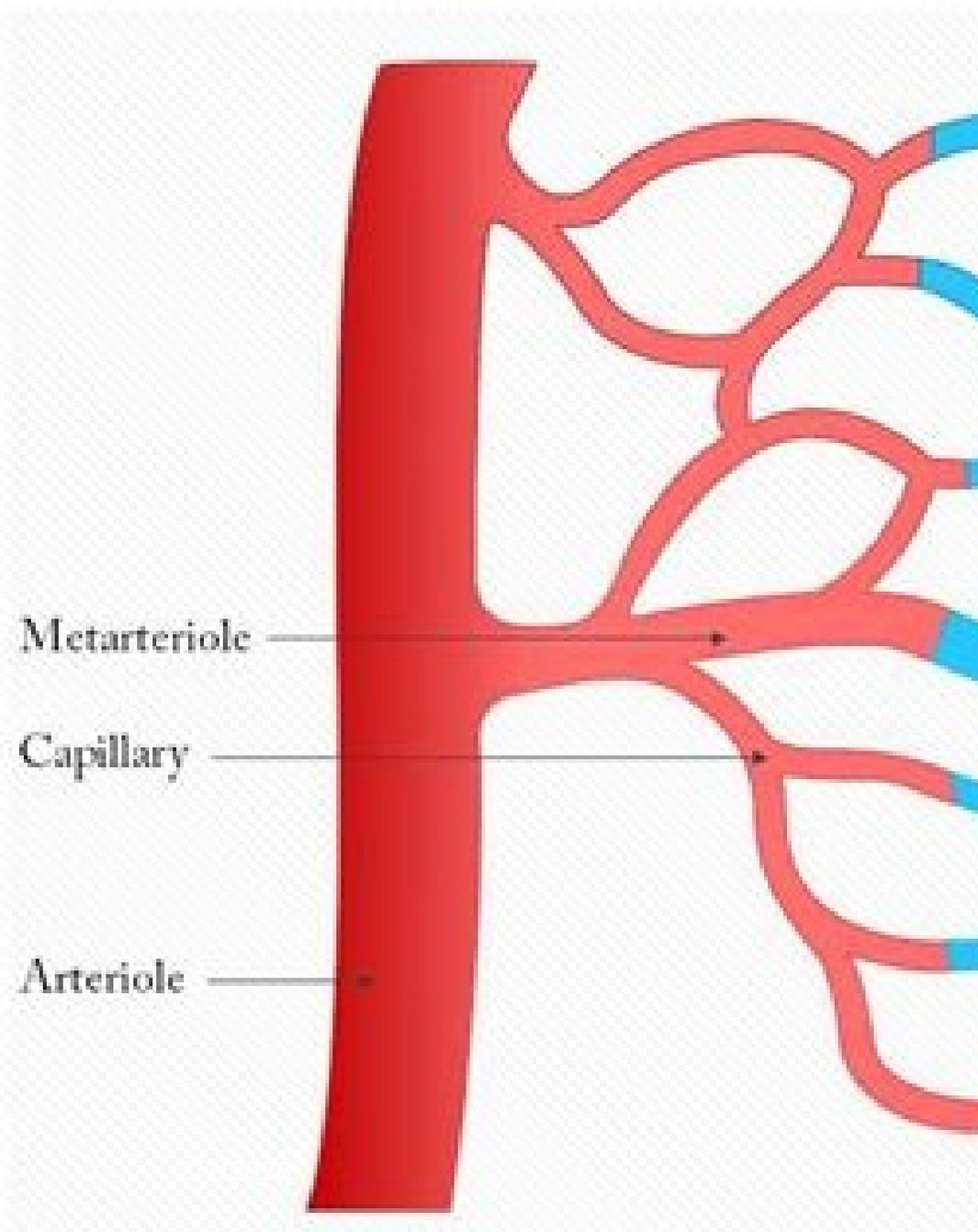


Proposed Mechanisms of Injury

*How Might the Sars-Cov-2
(Covid-19) Virus Caused
Sudden Deafness?*



Microvasculature



1. Microvascular Injury/Hypoperfusion

The cochlea has:

- End-artery blood supply (labyrinthine artery)
- No redundant circulation
- Extremely high metabolic demand
- Very low tolerance for ischemia

COVID is associated with:

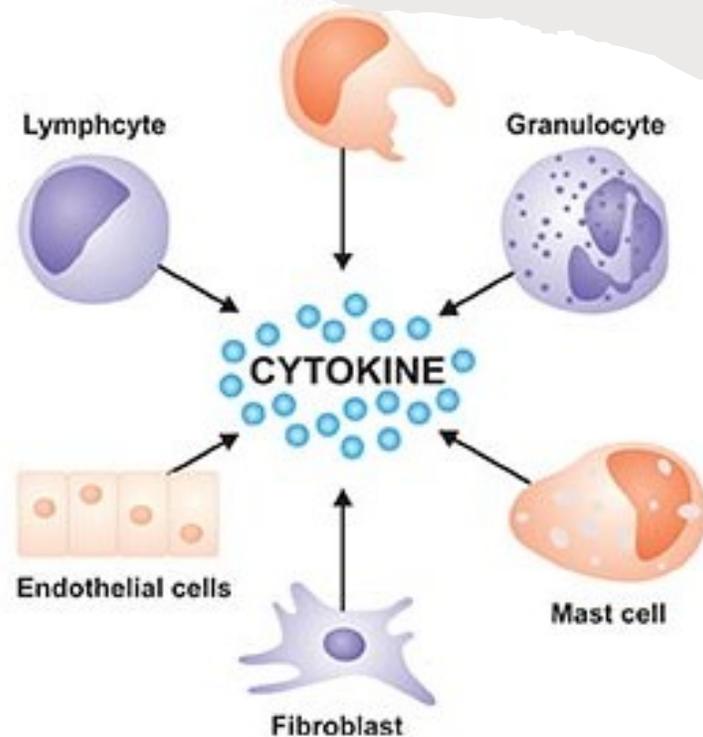
- Endothelial inflammation (endotheliitis)
- Microthrombi formation
- Impaired nitric oxide signaling
- Capillary flow dysregulation

Result:

- Reduced oxygen delivery
- Hair cell death
- Permanent high-frequency loss

This represents capillary-level ischemia, not large-vessel stroke.

2. Inflammatory Cytokine Toxicity



COVID-related inflammatory mediators include:

- IL-6
- TNF- α
- IL-1 β
- Interferons

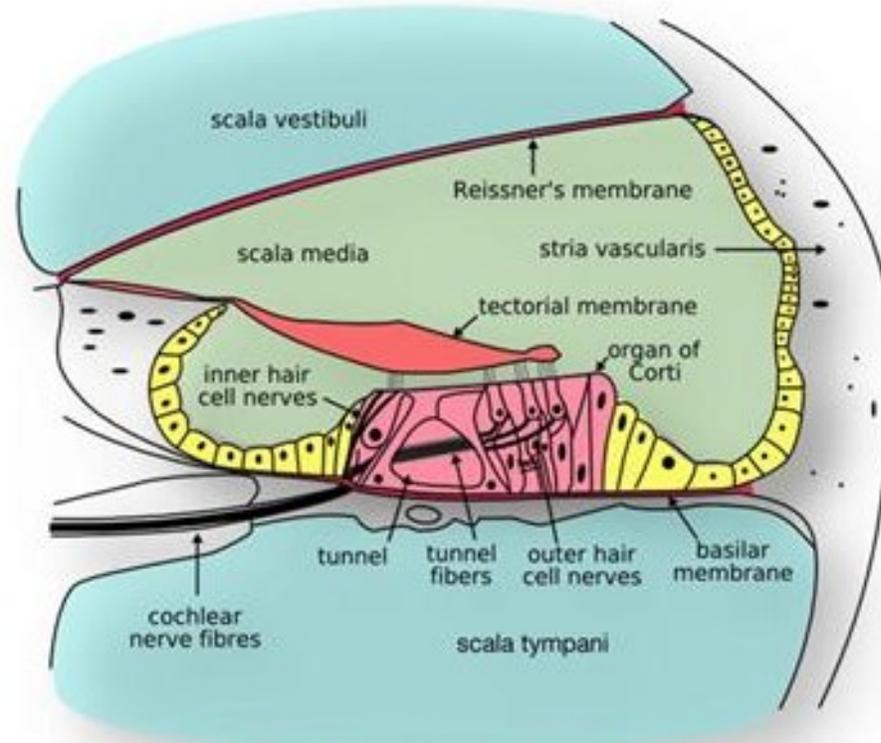
These cytokines:

- Cross the blood-labyrinth barrier
- Disrupt glutamate regulation
- Increase oxidative stress
- Trigger apoptosis in cochlear hair cells

Consequences:

- Outer hair cell loss
- Sound distortion
- Sound-induced pain
- Hyperacusis-like physiology
- Hair cells do not regenerate.

3. Stria Vascularis Dysfunction



The stria vascularis:

- Maintains endocochlear potential
- Regulates potassium cycling
- Is highly metabolically active
- Is sensitive to hypoxia and inflammation

Damage results in:

- High-frequency hearing loss
- Distorted sound processing
- Reduced benefit from amplification
- Persistent auditory dysfunction

Structural damage in this region is typically irreversible.

4. Auditory Nerve/Neuroinflammatory Component

COVID-associated neuroinflammation may involve:

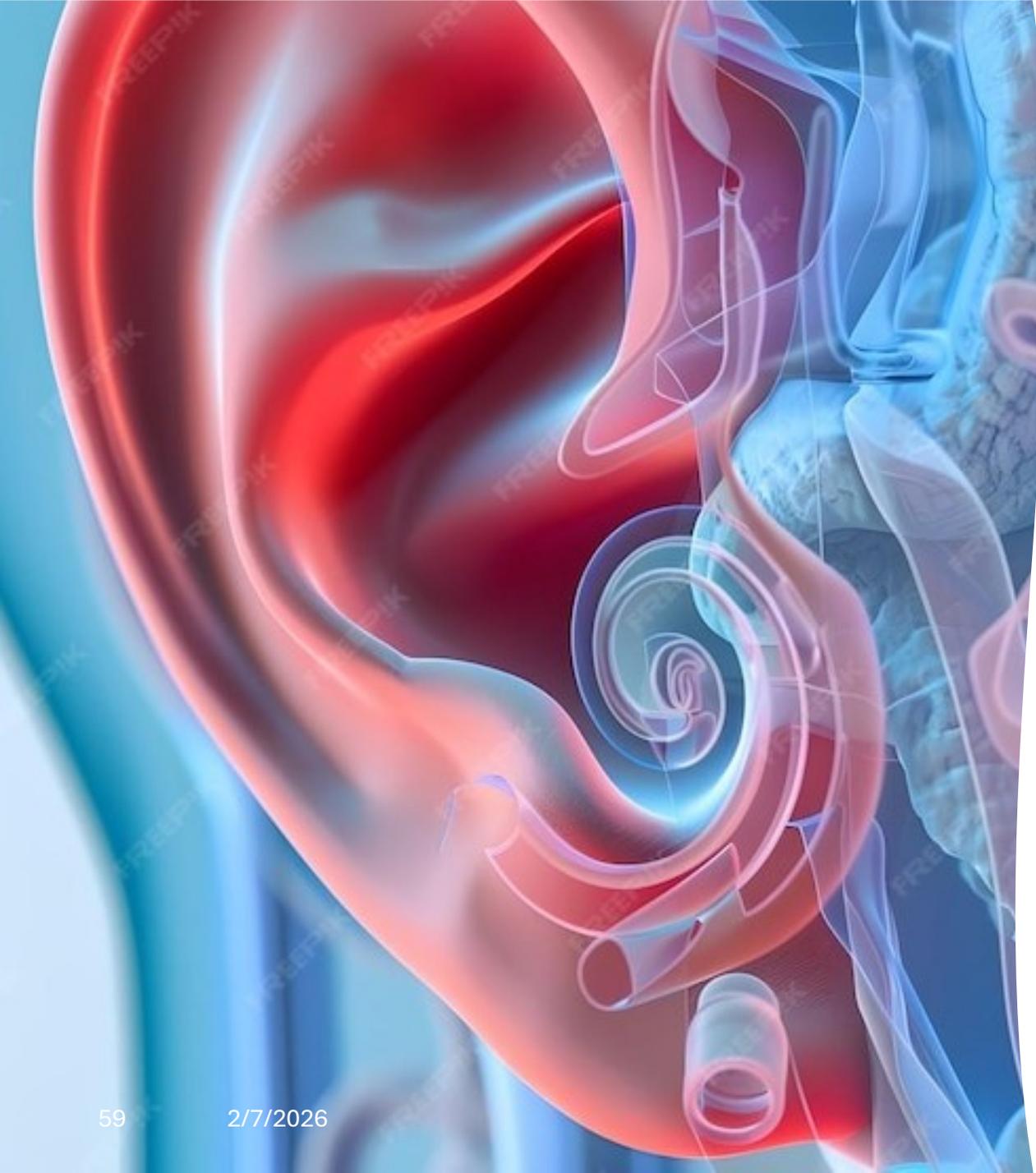
- Cranial nerve VIII
- Myelin integrity
- Central auditory pathways

Clinical implications:

- Amplification increases discomfort
- Distorted sound perception
- Poor speech discrimination
- Central auditory gain changes

This represents a retrocochlear or central sensitization component.





Integration of Mechanisms

Inflammation and blood flow disruption are interdependent:

- Inflammation damages endothelial cells
- Endothelial dysfunction impairs microcirculation
- Reduced perfusion increases inflammatory stress
- The cochlea lacks compensatory redundancy

Combined effect:

Microvascular ischemia + cytokine-mediated toxicity + neural sensitization



Why This Case Is Structurally Irreversible

- Basal cochlear hair cells destroyed
- Stria vascularis compromised
- Neural signaling altered
- Permanent audiologic changes

This is not:

- Conductive loss
- Mechanical obstruction
- Simple labyrinthitis
- This represents structural inner ear injury.



Secondary Central Effects

Following peripheral loss:

- Brain increases central auditory gain
- Sensory gating may change
- Internal sounds may emerge
- Perception becomes amplified or distorted

Central adaptation does not restore hair cells but influences symptom expression.

Summary of Most Likely Injury Pattern

Microvascular ischemia

Endothelial dysfunction

Cytokine-mediated hair cell toxicity

Neuroinflammatory sensitization

Biologically coherent explanation for COVID-associated cochlear injury.

Back to Susan - Clinical Case Extension

Baseline Status (Post-COVID Injury)

- Inner ear disruption following COVID infection (July 2022)
- Approximately 50% hearing loss
- Audiology confirmed irreversible inner ear damage
- Hearing aids ineffective
- High-frequency range most affected
- Pain associated with high-pitched sounds

Interpretation:

- Basal cochlear damage
- Sound amplification increases discomfort
- Structural, not mechanical, loss





Nicotine Trial

Nicotine Trial

- 7 mg transdermal nicotine
- Duration: 7 days
- Trial based on emerging long-haul COVID discussions
- No immediate adverse effects reported

New Observation After Trial

Client reported:

- Occasional internal auditory perception
- Described as “almost like tinnitus”
- Not constant
- Comes and goes
- Not frequent
- Not previously present

Clinical Interpretation of the New Sound

This pattern is:

- Intermittent
- Transient
- Non-progressive
- Not worsening baseline hearing

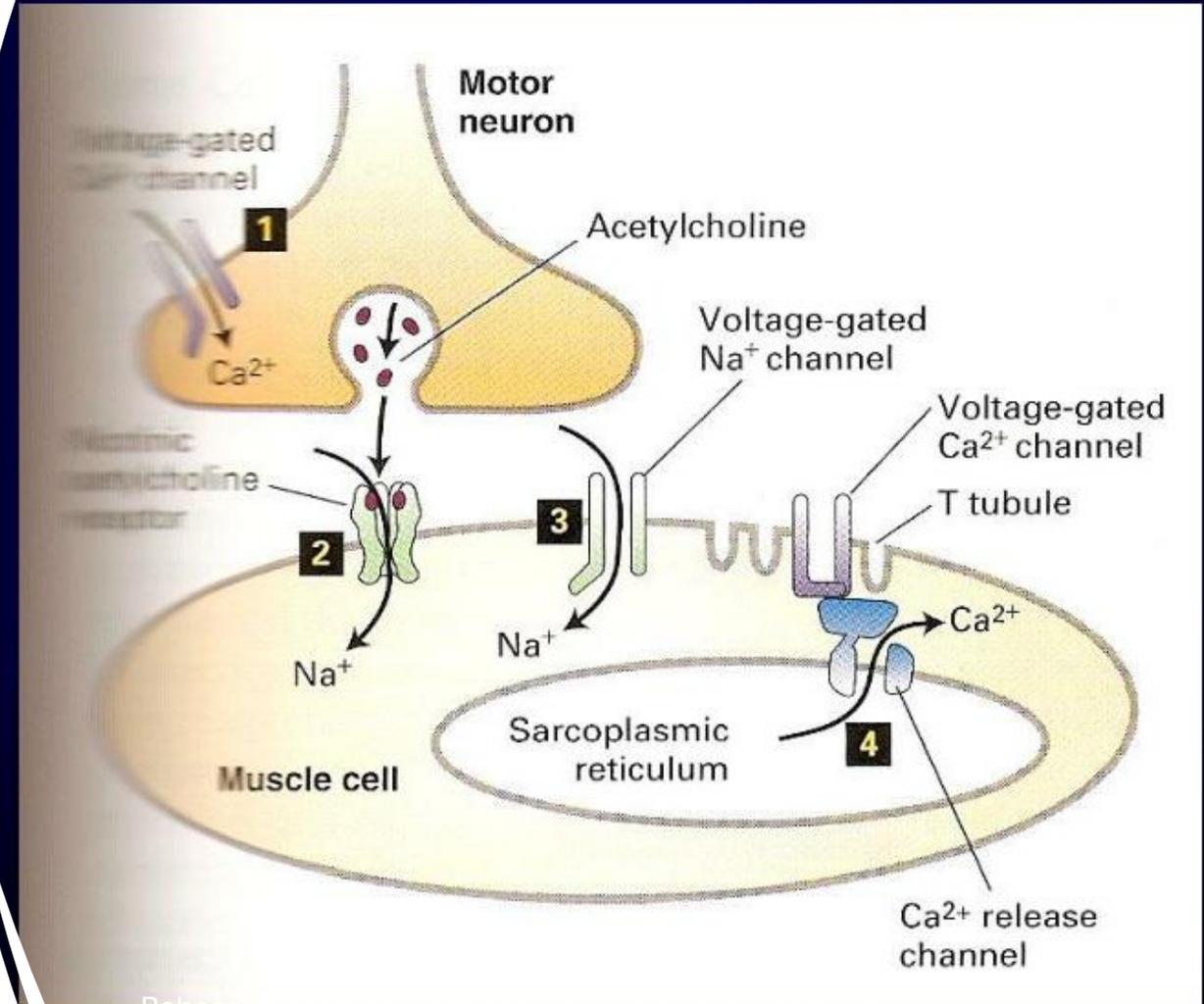
This is not consistent with new structural cochlear damage.



NICOTINIC ACETYLCHOLINE RECEPTOR

More consistent with:

- Transient auditory pathway activation
- Central gain modulation
- **Cholinergic influence on neural signaling**
- Sensory gating adjustment



Important Distinction

Structural damage:

- Permanent
- Stable
- Confirmed by audiology

Transient perceptual change:

- Central
- Neural
- Modulatory
- Dynamic

Nicotine does not regenerate hair cells. Any perceptual shift reflects central processing change, not cochlear repair.

Wrapping UP!

Today we've examined the major forms of hearing loss — how they differ, where they originate, and why understanding the mechanism matters. We've seen that aging and long-term noise exposure quietly place our hearing at risk, and that hearing loss can also appear suddenly, whether seemingly out of nowhere or following an acute event, as in Susan's case after COVID-19 infection. Next time, we'll move into auditory dysfunctions such as tinnitus and other sound perception changes, and then into vestibular distortions including vertigo and Ménière's disease. In the session that follows, we'll focus on what we can do proactively to protect and support our ears so we can preserve clear hearing for as long as possible.





Thank You for Joining Me!

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