



Occupational Health Clinics For Ontario Workers (OHCOW)

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Noise Induced Hearing Loss

Prevention

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Disclosures

- Medical consultant to OHCOW
- No conflict
- All pictures – “google search”





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Objectives



- Epidemiology
- Basic physiology / pathology
- Definitions
- Recommendations





Sound / Hearing

- Communication
- Protection



Noise

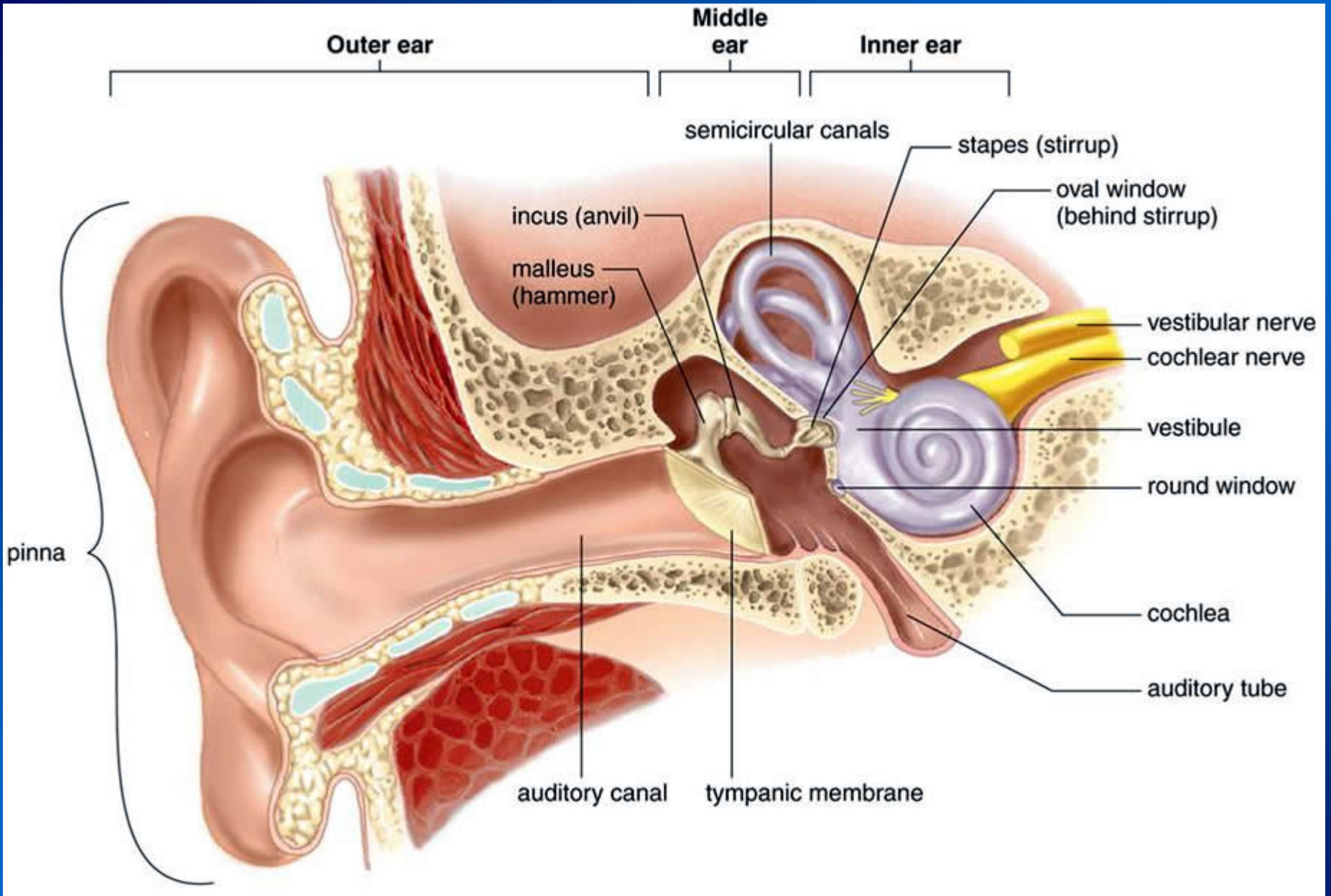
- Unwanted sound.
- Environmental and occupational pollutant.
- Health effects have been generally neglected.
- The most studied aspect of noise has been hearing loss. (OHL)

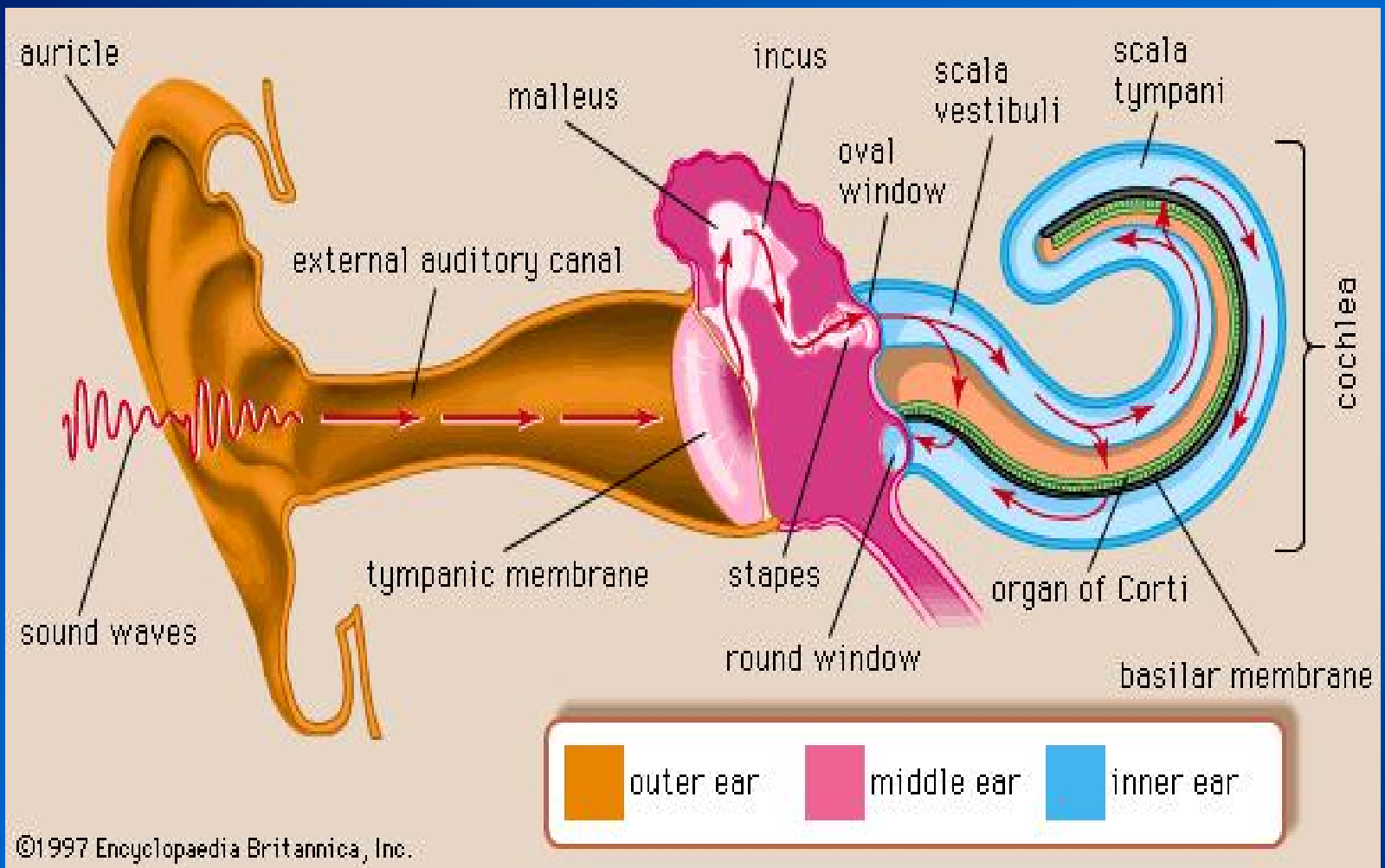


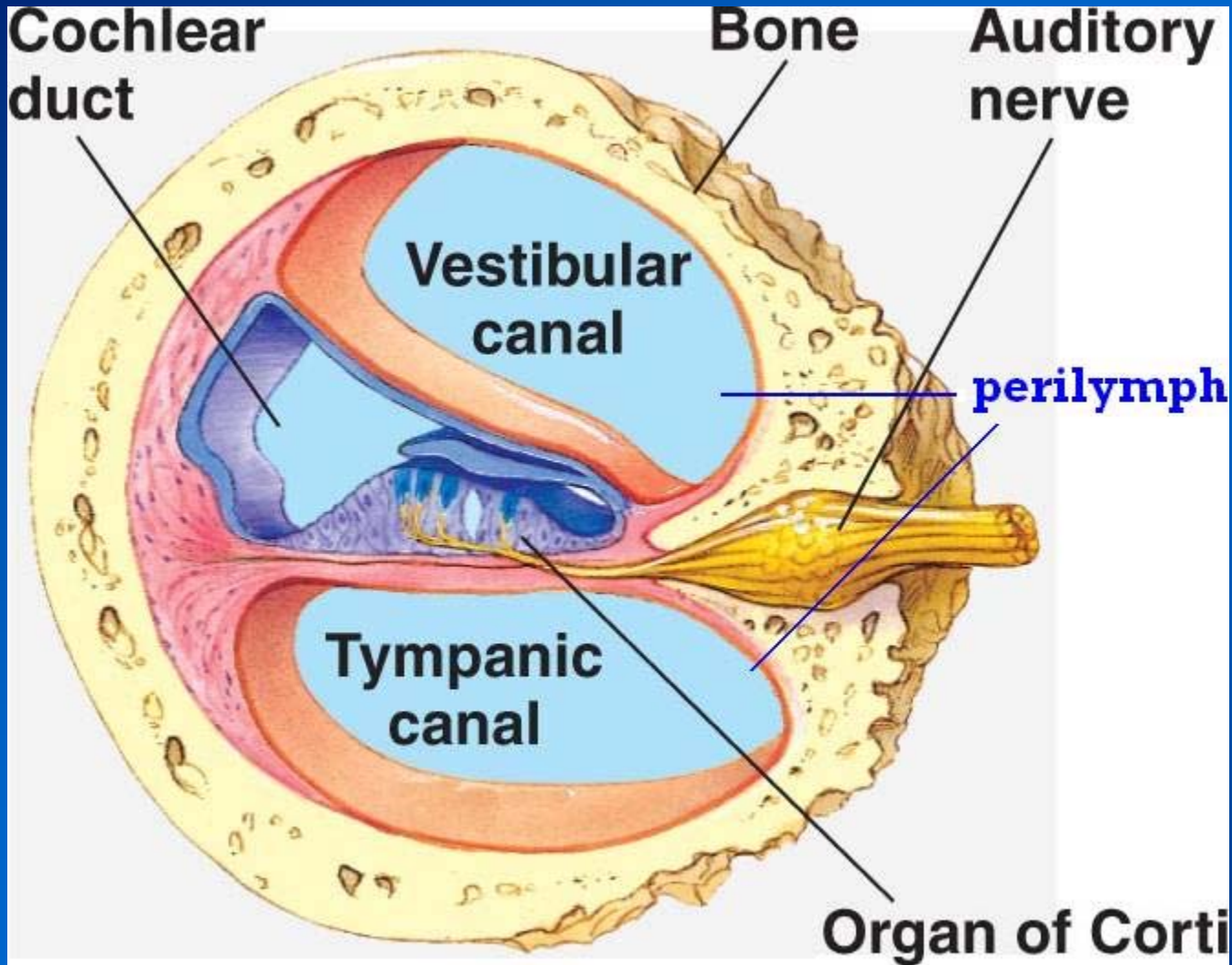
Terms

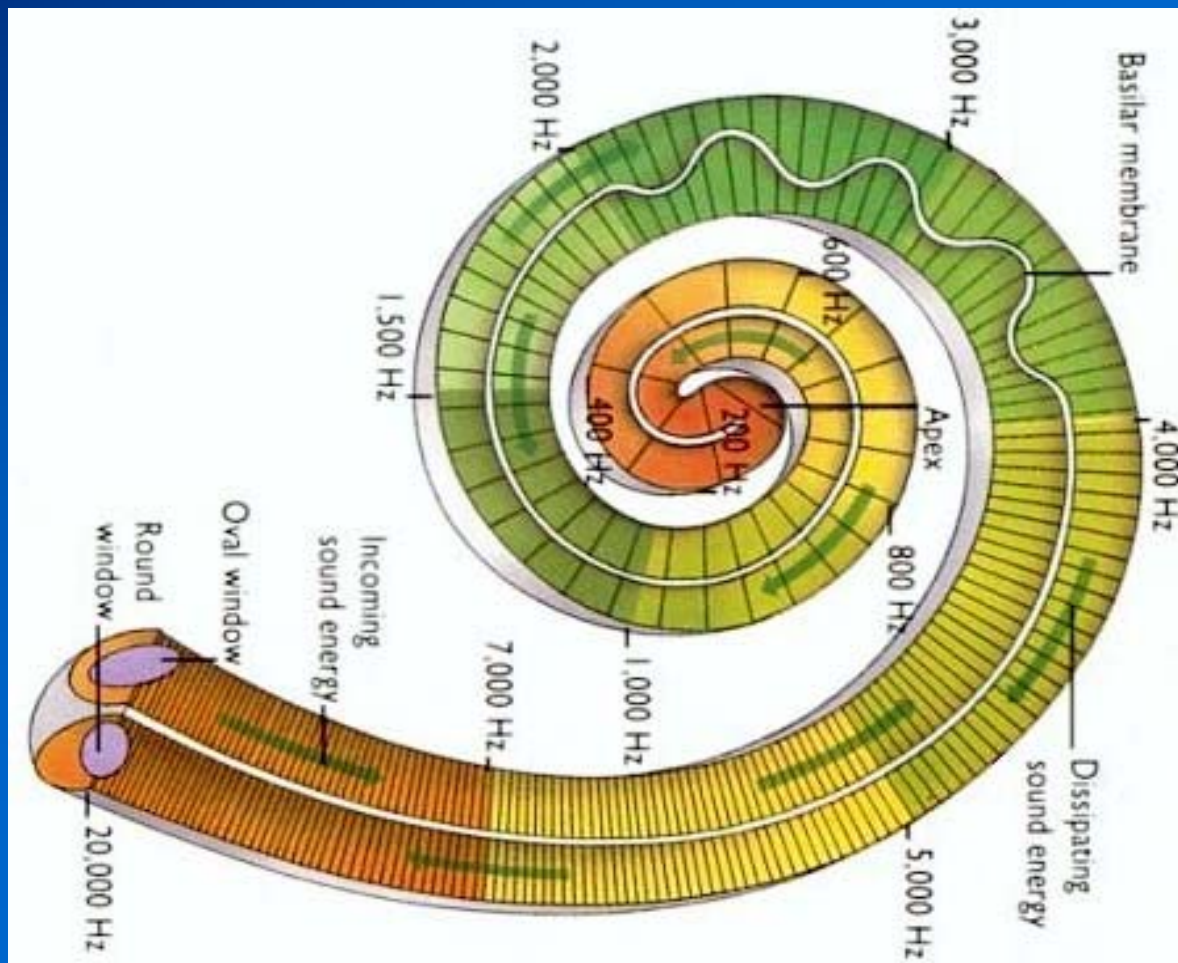
- TTS
- PTS
- Presbycusis
- Tinnitus

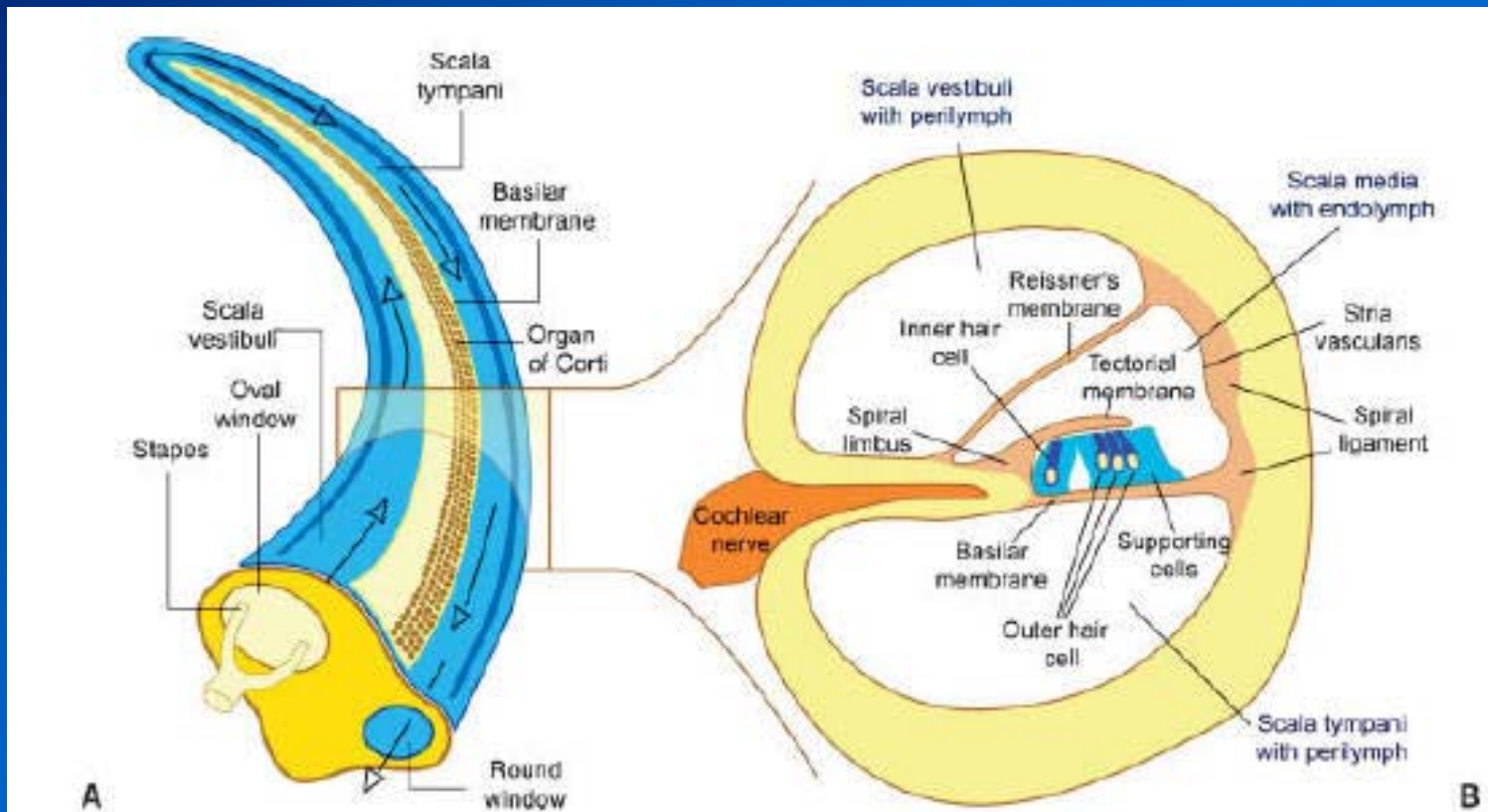


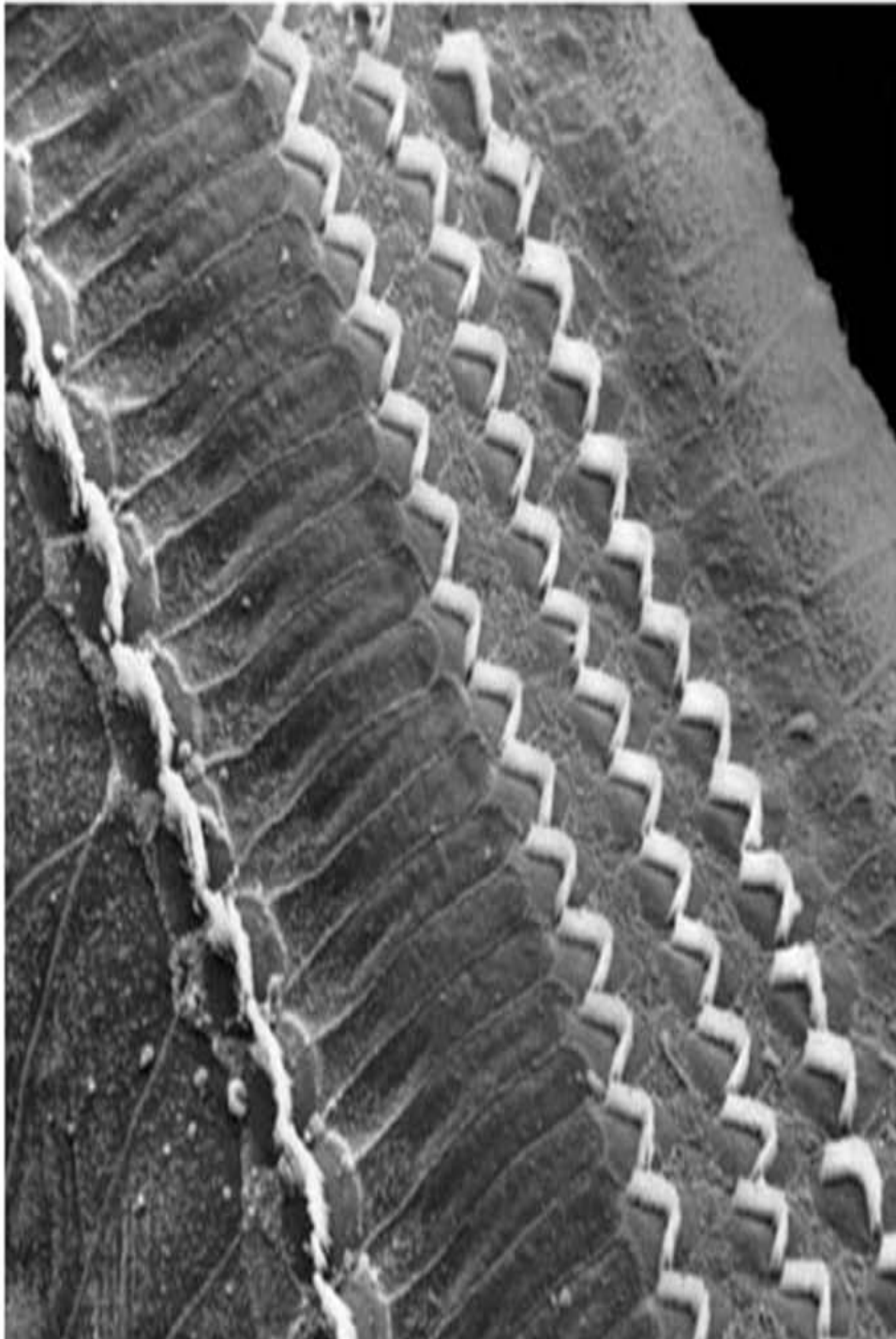


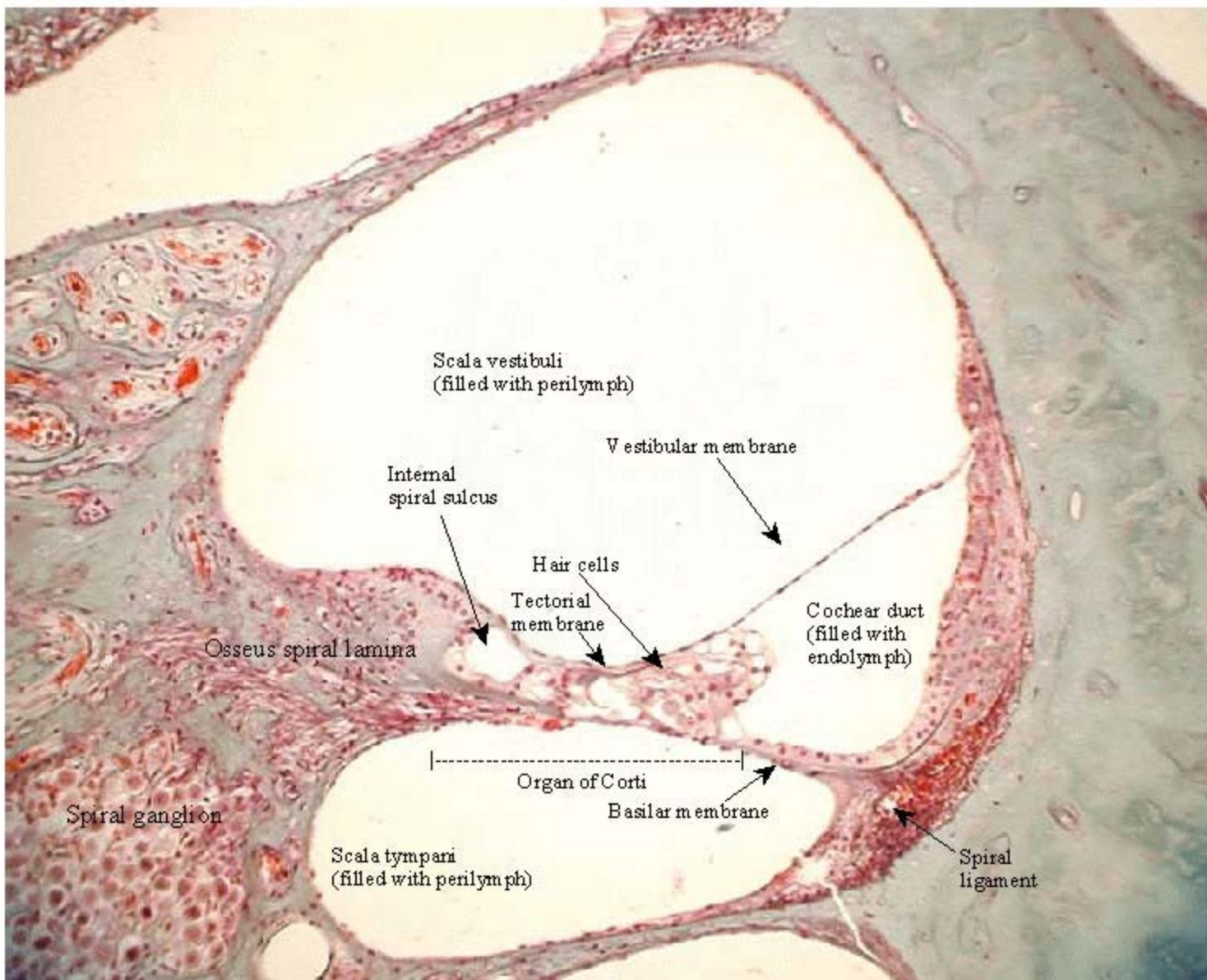












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How gene expression
goes off the rails

HAIR-CELL REGENERATION

Support cells in mature mouse ear
retain sensory-cell potential



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Hearing Loss

- Sensorineural
- Conductive
- Mixed



Noise Induced Hearing Loss

- Due to noise exposure.
- Second only to age-related hearing loss.
- Preventable cause of hearing loss.
- Complex condition influenced by environmental and genetic factors.
- Genetic factors may explain individual susceptibility.



Noise Induced Hearing Loss

- All age groups can be affected.
- Exposure from early childhood might have cumulative effects.



Noise Induced Hearing Loss

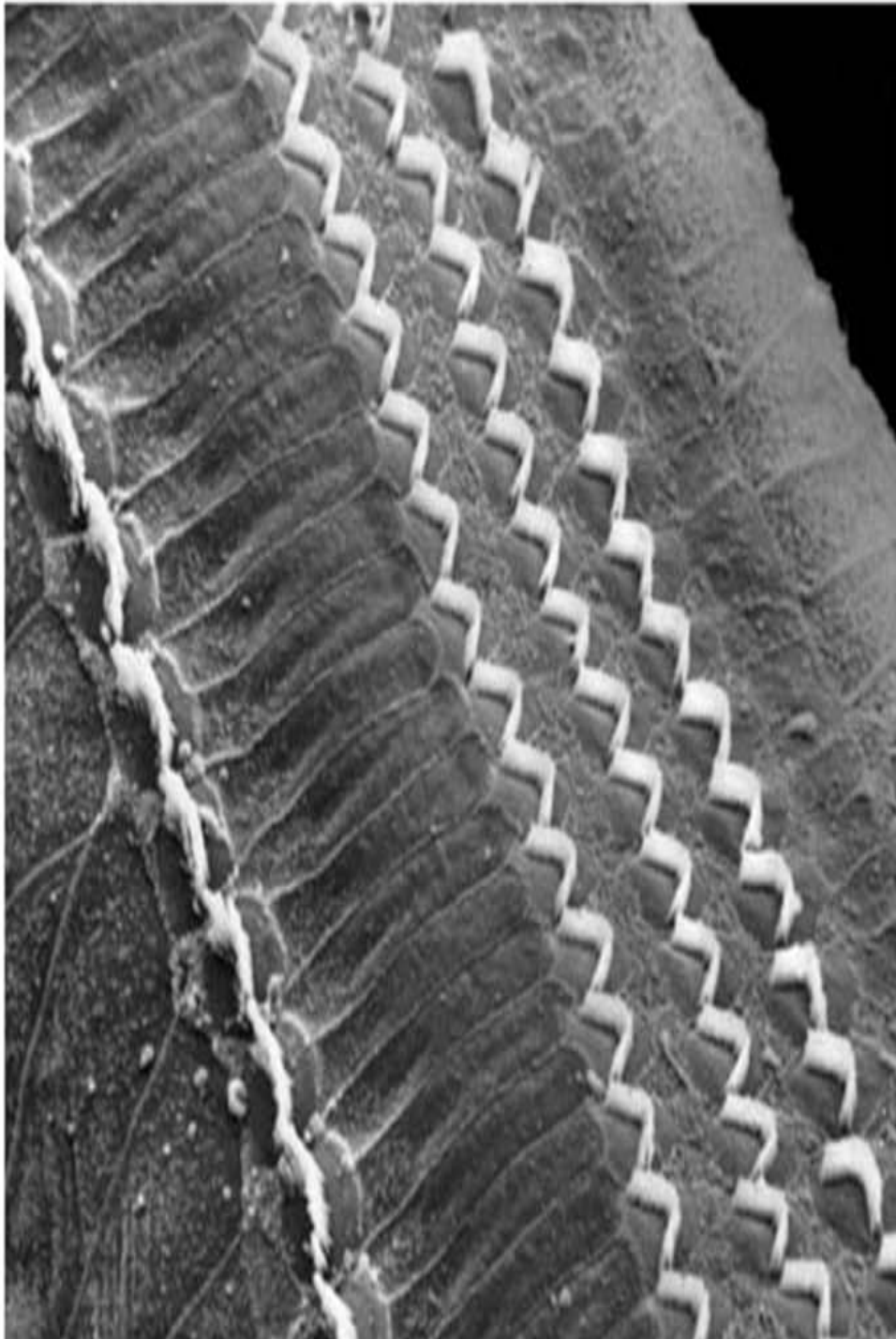
- Prevalence of hearing loss is highly related to age.
- NIHL - single intense significant exposure (explosion) or as a result of continuous longer term exposure.
- Severity is related to sound intensity duration of exposure.



NIHL

- 3 dB doubling rule.
- Types of noise exposure - transient and continuous.
- Most noise in industry is a combination.
- Pathology - loss is the loss of auditory sensory cells in the cochlea.





NIHL

- Hair cells cannot regenerate - no recovery
- Prevention is the only current option to preserve hearing.
- The hearing loss may range from mild to profound.



NIHL

- Decelerating process; the largest changes occur in the early years (5-10) with progressively smaller changes in the later years.
- This is in contrast to age-related loss, which accelerates over time.



NIHL

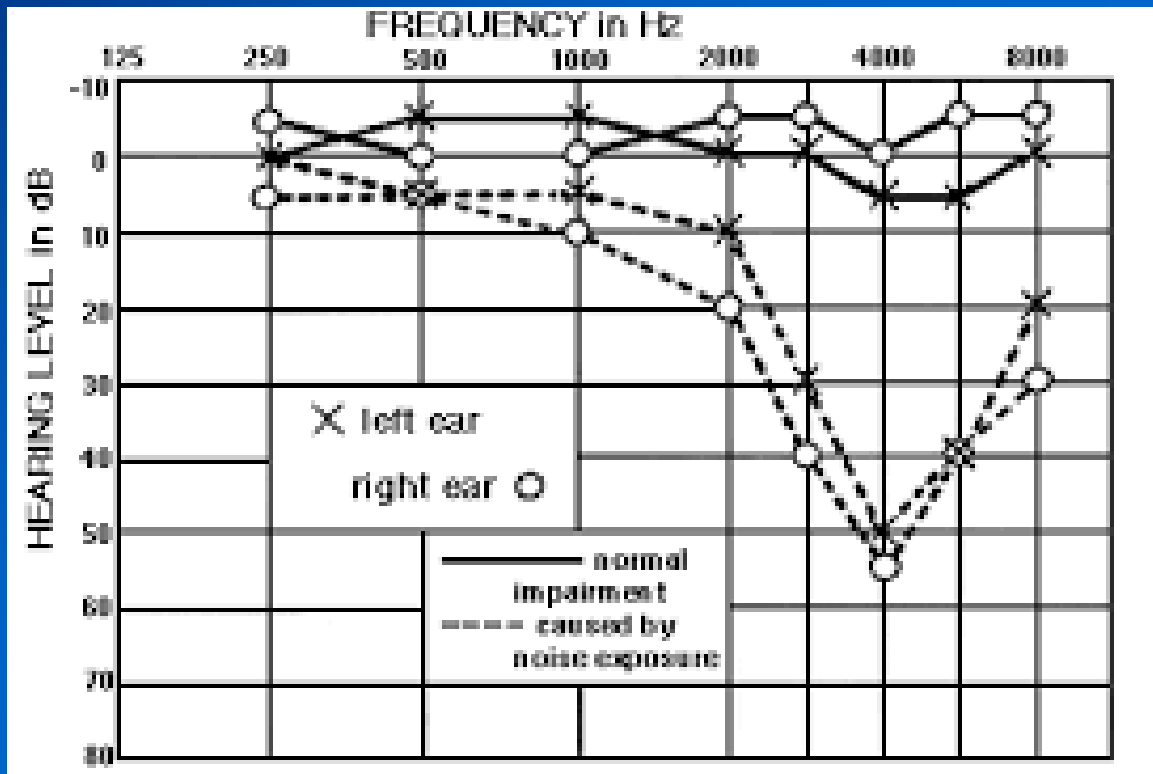
- Once the exposure to noise is discontinued, there is no substantial further worsening of hearing.
- Previous NIHL does not make the ear more sensitive to future noise exposure



NIHL

- First affects hearing in the 3-6 kHz range. The 4 kHz “notch” has been a classic finding.
- The lower frequencies essential for communication (i.e. 500, 1000 and 2000 Hz) are less affected.





NIHL

- Some noise sources e.g. impact noise, such as gunfire, jackhammers damage the higher frequencies severely before affecting the lower frequencies.
- NIHL is usually symmetrical.



NIHL

- If asymmetrical HL, this is usually related to the fact that one ear receives a greater exposure to the noise than another.
- When asymmetric sensorineural hearing loss exists - need to exclude pathologic causes (i.e. tumours, other inner ear disorders, etc.)



- NIHL is associated with injury to the inner ear (cochlear) and damage to the auditory pathway.
- NIHL is a preventable condition, and the MOL needs to play a critical role in educating workers.
- Majority of prevention is directed at hearing protective devices. A strategy that is at the bottom of the hierarchy of controls of hazards.



- For various reasons hearing protective programs have not been as successful as desired.



- An accelerating incidence of high-frequency hearing loss in younger individuals points to early, chronic noise exposure, possibly from personal entertainment devices.



- Current research on the administration of certain antioxidants or dietary supplements before or after noise exposure shows promise for developing a pharmacologic treatment.





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Sound Masking / White Noise



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Examples of Sound Pressure

- Whisper 20
- Quiet room 30
- Normal Conversation 50
- Normal City noise 65
- Chainsaw 110
- Jet engine 140



Burden of Disease

- Public health problem.
- Global Burden of Disease 2010-11 estimated that 1.3 billion people are affected by hearing loss.
- Onset usually insidious / compensation
- Disability ranges from negligible to profound



Burden of Disease

- Adult-onset hearing loss unrelated to a specific disease process accounted for 79% of YLD.
- In the USA and Europe, 26% of adults have a bilateral hearing disorder that impairs their ability to hear in noisy environments.
- WHO estimates that 10% of the world population is exposed to sound pressure levels that could potentially cause noise-induced hearing loss..



Key Strategic Objectives

The strategic objectives previously identified remain unchanged:

1. Focus on reducing harmful exposures
2. Establish appropriate reporting and surveillance mechanisms
3. Ensure maximum use of best evidence



Key Strategic Objectives

4. Improve education and awareness
5. Target high priority exposures, and industries
6. Promote ongoing engagement and strategic partnerships.



Prevention

- A stronger focus on prevention and having the necessary incentives in place will help ensure workers have the opportunity to avoid work-related NIHL.
- The Chief Prevention Officer provides leadership for this work.



- The mandate for the prevention of workplace injuries and illness was previously held by WSIB. In 2012, this mandate moved from the WSIB to the Ontario Ministry of Labour. The WSIB, through its legislative obligations, continues to provide funding to the Ontario Prevention System. In 2013, the WSIB contributed approximately \$250M to the MOL to prevent workplace injuries and illnesses.



An effective hearing conservation program

- Engineered solutions to reduce workplace noise
- Adequate education, awareness and training programs
- Baseline and scheduled audiogram testing
- Continuous auditing of the effectiveness of hearing conservation program



These controls should be considered in the following order:

1. Elimination of the hazard

- Remove the hazard.
- Generally there has been no or insignificant input into the development of machines / processes where the aim was noise reduction.
- Usually noise reduction is an “afterthought”



These controls should be considered in the following order:

- More emphasis needs to be placed into the initial development of machines / process where one of the targeted outcomes is noise reduction / elimination. There should be tangible incentives to achieve this goal.
- Similar principles of car emission. Once the standards / direction were set the manufactures went all out to achieve them, with success.



2. Substitution

- Replace the substance or process with a less hazardous one.

3. Engineering controls

- These include designs or modifications to plants, equipment, and processes that reduce the source of noise exposure.



- The MOL website states, “the preferred and most effective way to control noise exposure is through engineering controls at the source or along the path of transmission



4. Administrative controls

- Controls that alter the way work is done, including timing of work, risk assessments, signage and workplace policies.

Administrative controls also include work practices such as standards and operating procedures, including, training, housekeeping, equipment maintenance and personal hygiene practices.



5. Personal protective equipment

- As endorsed by the MOL, In keeping with good health and safety practice, hearing protection devices (HPDs) should always be considered as a last resort.



- There has been a general over-reliance on hearing protection devices for which the actual performance in the workplace is much poorer than claimed.
- HCPs are often inadequate or even absent in noisy industries
- Poor compliance.
- Lack of enforcement



- These devices are often less protective than their ratings, due to such factors as improper selection, poor fit, deterioration, user discomfort, and lack of user motivation - Source: Ministry of Labour.



- KPMG audit mentioned research from the UK and other countries have indicated that most of the workers expected to use hearing protection either get no protection whatsoever or the performance of their Personal Protective Equipment (PPE) is inadequate.



- Peer group pressure and group behavior plus reluctance of supervisors to enforce wearing protection are cultural factors that inhibit the effectiveness of a PPE strategy
- A strategy focused solely or heavily on PPE is not enough to mitigate the risk associated with noise in the workplace.



- Research has shown that hearing protection was most effective in companies where it was implemented as part of a comprehensive HCP.
- “Buy quiet” programs, the labeling of noisy machinery, and various incentives or rewards for quieter workplaces are all recommended.



Recommendations

- A) Reducing noise level exposure from 85dBA to 80dBA



- This previous OHCOW recommendation remains unchanged. The evidence is still sufficient to support that a reduction in noise level exposure will lead to a decrease in the overall disability burden. This recommendation also needs to be considered in the context that our background environmental noise exposure in modern society has substantially increased.



- As a short term, easily achievable goal the action level can be set at 80dBA – requiring employers to provide education, monitoring and to offer protection if required.



- The European Union Directive 2003/10/EC (which is over 10 years old) has an action level of 80 dBA
- Employers must provide information and instruction, HPD are made available, and workers have a right to audiometric testing



Ototoxic Chemicals

- B) Recognizing ototoxic chemical exposure (including heavy metals and gases): (OHCOW 2014)
- For a long time it has been recognised that certain chemical can affect hearing. To date this significant co-exposure has been largely ignored.



- This effect can cause HL independently or work synergistically with hazardous noise to cause HL.
- Exposure can be via the blood stream (dermal absorption and or inhalation) or direct physical exposure (airborne). The structure and / or functioning of the inner ear can be affected. There can be damage to the peripheral and or central nervous system.



- Ototoxic agents generally produce patterns of damage that mimic age-related hearing loss (high-frequency).
- The exposure threshold for such ototoxic effects is generally unknown, therefore audiometric monitoring may be necessary to determine if the substance is affecting the hearing.



- USAPHC has recommended annual audiograms for workers whose airborne exposures, without regard to respiratory protection worn, are at 50% or more of the OEL for the substance in question, regardless of the noise level. The >50% OEL, while somewhat arbitrary, will ensure the collection of data from sub-OEL exposures. This is more stringent than the OSHA Permissible Exposure Limit or ACGIH Threshold Limit Value



- The Nordic Expert Group (Johnson & Morata, 2010) classified three categories of ototoxic chemicals based on the strength of the evidence from human and animal data. These are divided into know causes, suspected causes and unlikely causes.



- Known - Styrene, toluene, carbon disulphide, Pb, Hg, CO
- Suspected - para-xylene, ethylbenzene, hydrogen cyanide



- Acrylonitrile
- Arsenic
- Carbon Disulfide
- Carbon Monoxide
- Chemical Warfare Agents
- Cyanide
- Ethyl Benzene
- Fuels
- Heptane
- Mercury Compounds
- Manganese
- Methyl Ethyl Ketone
- n-Hexane
- Organic Tin (Sn)
- Organophosphate Pesticides
- Paraquate
- Lead Compounds
- Perchloroethylene
- Stoddard Solvent
- Styrene
- Toluene
- Trichloroethylene
- Xylene



Recognition of the non – auditory effects of Noise

- Noise exposure (occupational and environmental) has health effects other than hearing loss.
- Excessive noise exposure has been shown to affect the autonomic nervous system and cortisol (stress hormone) levels.



- Hypertension
- Cardiovascular disease
- The psychological effects of hearing loss are often ignored (e.g. social isolation).
- Undiagnosed hearing loss has also been implicated in an increase in accidents



The WSIB web site lists the following non auditory health effects:

- high blood pressure
- increased risk of heart disease
- increased stress levels
- tiredness
- irritability
- hormonal changes
- low birth weight babies



- From a public health perspective observational and experimental studies have shown that noise exposure leads to annoyance, disturbs sleep and causes daytime sleepiness, affects patient outcomes and staff performance in hospitals, increases the occurrence of hypertension and cardiovascular disease, and impairs cognitive performance in schoolchildren



- The previous OHCOW review provided supporting evidence and is not re-iterated.



- In collaboration between Canadian and Dutch researchers, Davies and van Kamp (2012), reviewed the literature regarding the association of noise and cardiovascular disease and concluded that “the weight of evidence clearly supports a causal link.” (page 287). Girard et al., (2014), looked at the cardiovascular health of retired workers who had been exposed to occupational noise and found that the cardiovascular effects continued even after exposure ceased.



- Annoyance associated with noise is recognized as a major factor in the stress-related health effects of noise exposure. The annoyance associated with tonal sounds is recognized by ISO standard ISO:1996 (OHCOW 2014)





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Pregnant Workers

- We recommend the regulation include a provision to allow pregnant workers to not be exposed to more than 80 dBA



- .
- Sound is well transmitted into the uterine environment. The human cochlea and ears develop by 24 weeks of gestation. By 28 weeks of gestation, the auditory pathways are consistently functioning. The initial threshold of hearing of the fetus is greater than the adult, 40 dB. This value reduces to 13.5 dB by 42 weeks of gestation



- An increased risk of shortened gestation has been shown in four studies. Women exposed to 80 dB for an 8-hour shift were at increased risk of preterm delivery
- Decreased birth weight has also been associated with noise exposure.



- The American Academy of Pediatrics Sound Study Group broadened the recommendations of elevated sound exposure in neonatal ICU (NICUs) to include the fetus (Graven, 2000).



- With respect to noise exposure the Sound Study Group's recommendations for the fetus were - women should avoid prolonged exposure to low-frequency sound levels (<250 Hz) above 65 dB during pregnancy (Graven, 2000).



- In Germany, there is legislation to protect pregnant workers from exposures above 80 dBA Lex,8 (<http://www.hsu-hh.de/download->





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Noise and Acoustics

Hazardous noise exposures can occur

On the Job



Off the Job

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Community Partnerships

- In our modern society noise pollution has become an ubiquitous part of our daily living. Many countries have or are starting to regulate environmental noise. In addition to this background noise, with the advent of personal music players the exposure to high level noise has become an almost daily occurrence.



- Given the high background environmental noise exposure level the current workers entering the field are already pre-disposed to hearing and other health problems. This burden of disease is expected to increase.



- Therefore given this high pre-work environmental exposure it is recommended that the MOL form alliances with Public Health organisations to promote healthy hearing.





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- auditoryneuroscience.com

