# Stem Cells and Cell Replacement Therapy for Sensorineural Hearing Loss

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# Regenerative Medicine Using Stem Cells and CRT for Sensorineural Hearing Loss

Sensorineural hearing loss is impacted by the inner ear. Sensorineural hearing loss refers to any cause of hearing involving the cochlea, auditory nerve, or central nervous system.[5] Hearing aids cost about $100 - $150 to manufacture but they can cost up to $5,000 for one hearing aid. Hearing aids only amplify sound, they do not help with the other issues associated with hearing loss such as balance.

Regenerative medicine using stem cells and CRT (Cell Replacement Therapy) could help make this possible by isolating cells from a patient and converting them into the cells that are needed by that patient to restore the body's lost function.[8] Induced Pluripotent Stem Cells (iPSCs) are self-renewable and can differentiate to different types of adult cells.[7] Recreating actin-based protrusions required on auditory and vestibular sensory cells could help fix the balancing issues associated with hearing loss.

Stereocilia bundles are arranged in 3 V-shaped rows of different heights, inner ear being the shortest, outer ear the tallest. Thread-like strands called tip links connect tips of shortest to stereocilia to the sides of adjacent taller ones, when sound vibrations enter the inner ear, the stereocilia move, causing the tip links to open in channels. Short stereocilia bundles could be regenerated by copying protein coding, using cell replacement therapy and introducing a transcription factor that promotes hair cell regeneration.[6] MYO7A gene myosin VIIA, CDH23 gene cadherin related 23, STRC gene stereocilin, TBC1D24 gene TCB1 domain family member 24 would be beneficial in the role of redevelopment and cellular reproduction necessary to accomplish this.

The MYO7A gene provides instructions for making a protein called myosin VIIA. These proteins help transport molecules within cells. Myosins interact with actin, a protein that is important for cell movement and shape.[1] The CDH23 gene provides instructions for making cadherin 23, a type of protein that helps cells stick together. Different versions of this protein are made in different cell types, a longer version in the inner ear. Cadherin 23 interacts with other proteins in the cell membrane as part of a protein complex that is involved in cell attachment.[2] The STRC gene provides instructions for making a protein called stereocilin. Stereocilin helps to maintain the structure of stereocilia by linking their tips to one another. Stereocilia bend in response to sound waves, triggering a series of reactions within hair cells that generate a nerve impulse. Such nerve impulses are transmitted via the auditory nerve to the brain, where they are interpreted as sound.[3] The TBC1D24 protein belongs to a group of proteins that are involved in the movement (transport) of vesicles, which are small sac-like structures that transport proteins and other materials within cells. The TBC1D24 protein is also active in stereocilia.

Human pluripotent stem cells such as embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) provide unprecedented opportunities for cell therapies against intractable diseases and injuries. Using regenerative medicine in the reproduction of short stereocilia bundles and tip links would allow people to live a better-quality life. It could help restore balance for those suffering from sensorineural hearing which is something hearing aids are not capable of doing.

# References

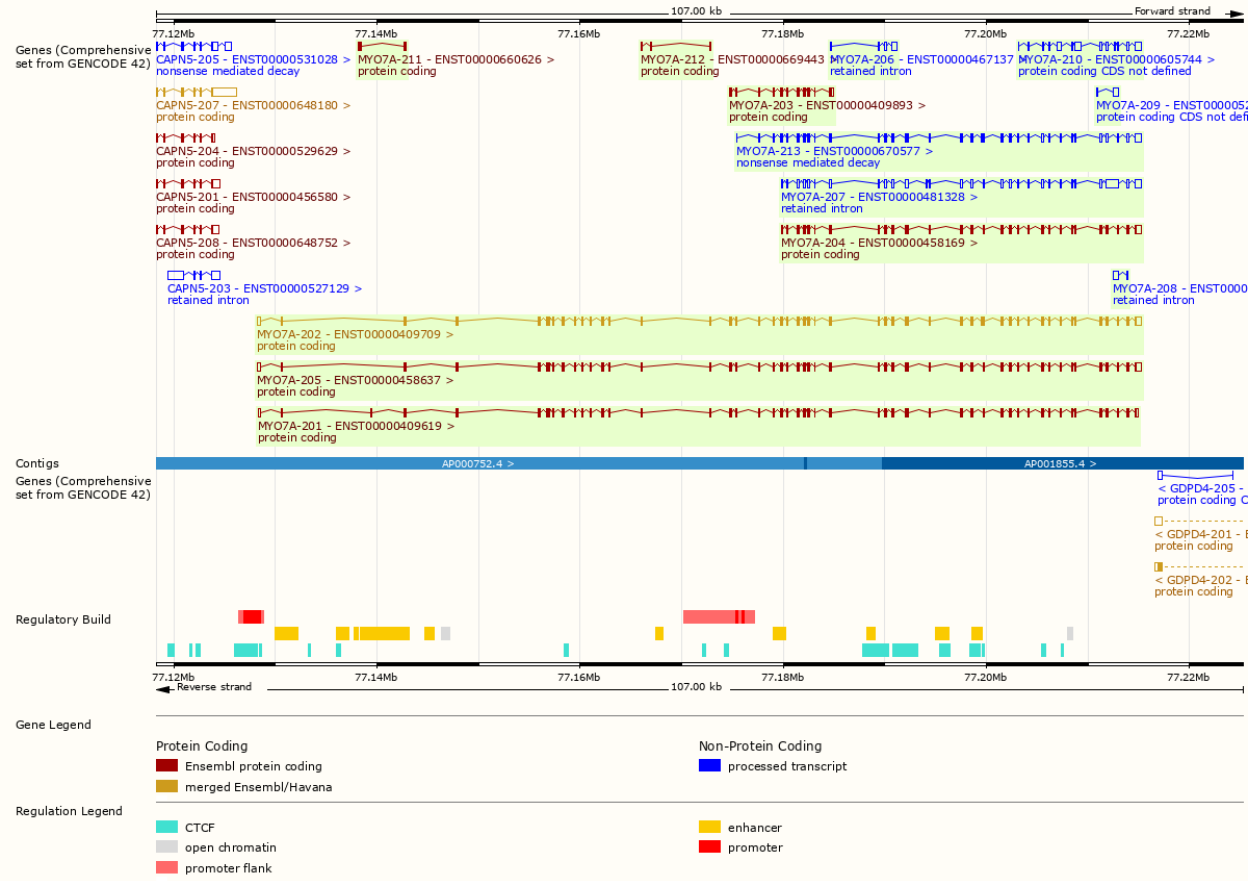
1. MYO7A gene: MedlinePlus Genetics. (n.d.). Retrieved from medlineplus.gov website: https://medlineplus.gov/genetics/gene/myo7a/
2. CDH23 gene: MedlinePlus Genetics. (n.d.). Retrieved from medlineplus.gov website: https://medlineplus.gov/genetics/gene/cdh23/
3. STRC gene: MedlinePlus Genetics. (n.d.). Retrieved from medlineplus.gov website: https://medlineplus.gov/genetics/gene/strc/
4. TBC1D24 gene: MedlinePlus Genetics. (n.d.). Retrieved from medlineplus.gov website: https://medlineplus.gov/genetics/gene/tbc1d24/
5. Tanna RJ, Lin JW, De Jesus O. Sensorineural Hearing Loss. In: StatPearls. Treasure Island (FL): StatPearls Publishing; May 15, 2022.
6. TB Crowson, M. G., Hertzano, R., & Tucci, D. L. (2017). Emerging Therapies for Sensorineural Hearing Loss. Otology & neurotology : official publication of the American Otological Society, American Neurotology Society [and] European Academy of Otology and Neurotology, 38(6), 792–803. https://doi.org/10.1097/MAO.0000000000001427
7. Singh VK, Kumar N, Kalsan M, Saini A, Chandra R. Mechanism of Induction: Induced Pluripotent Stem Cells (iPSCs). J Stem Cells. 2015;10(1):43-62. PMID: 26665937.
8. Cell Replacement Therapy (CRT). (2022, April 23). Retrieved October 21, 2022, from Biotech Bae website: https://biotechbae.com/cell-replacement-therapy-crt/

# Review Attached NCBI Dataset

| Gene ID | Symbol | Gene name | Synonyms | Gene type |
|---|---|---|---|---|
| 4647 | MYO7A | myosin VIIA | DFNB2, MYU7A, NSRD2, USH1B, DFNA11, MYOVIIA | protein-coding |
| 64072 | CDH23 | cadherin related 23 | PITA5, USH1D, CDHR23 | protein-coding |
| 161497 | STRC | stereocilin | DFNB16 | protein-coding |
| 57465 | TBC1D24 | TBC1 domain family member 24 | FIME, DEE16, DOORS, TLDC6, DFNA65, DFNB86, EIEE16, EPRPDC | protein-coding |

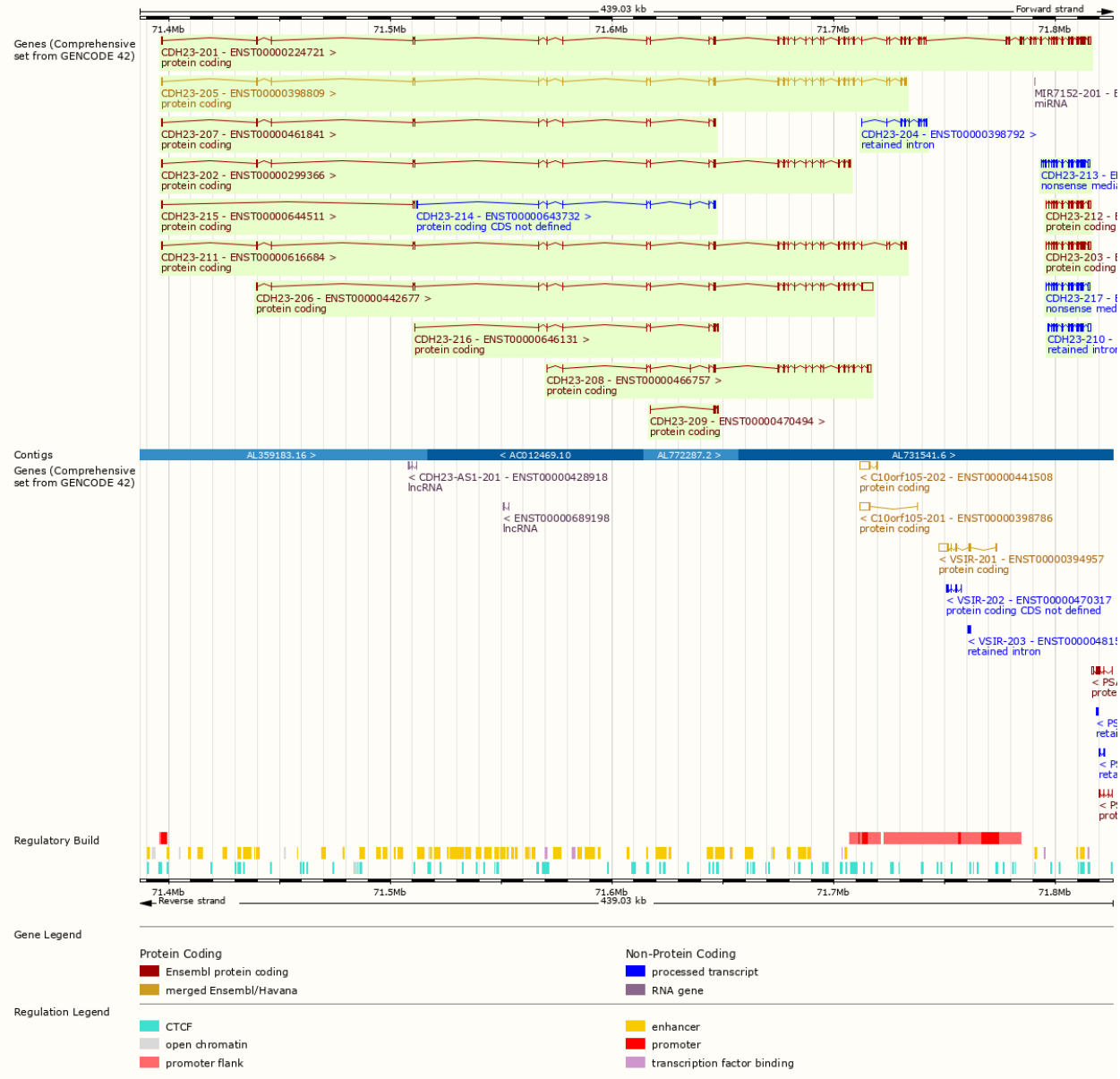
*NCBI – National Library of Medicine – National Center for Biotechnology Information.* Retrieved October 24, 2022, from https://www.ncbi.nlm.nih.gov/datasets/tables/genes/?table_type=genes

# Gene: MYO7A ENSG00000137474



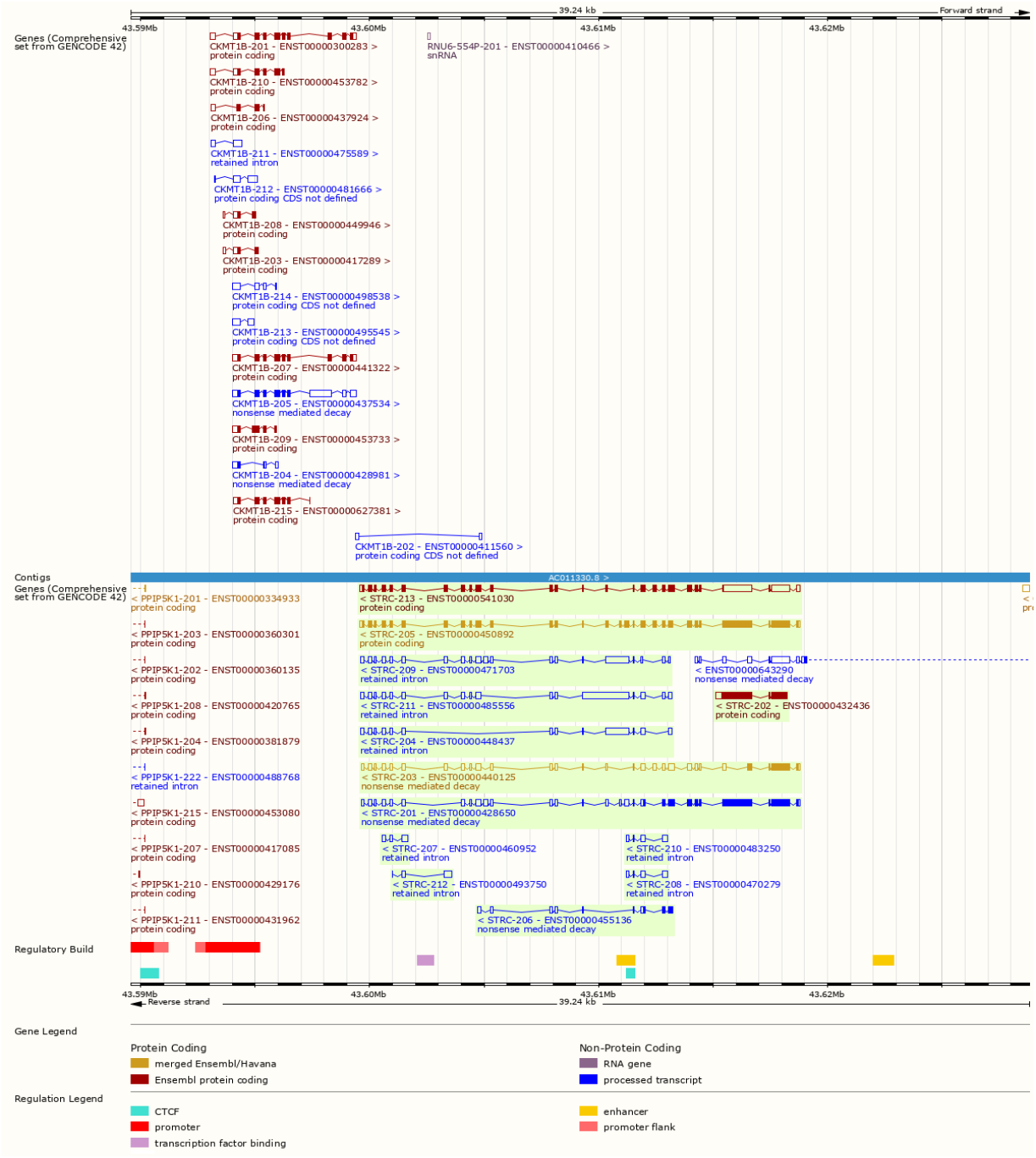

*Gene: MYO7A (ENSG00000137474) - Summary - Homo_Sapiens - Ensembl Genome Browser 108*. useast.ensembl.org/Homo_sapiens/Gene/Summary?db=core;g=ENSG00000137474;r=11:77128246-77215241. Accessed 23 Oct. 2022.

Gene: CDH23 ENSG00000107736



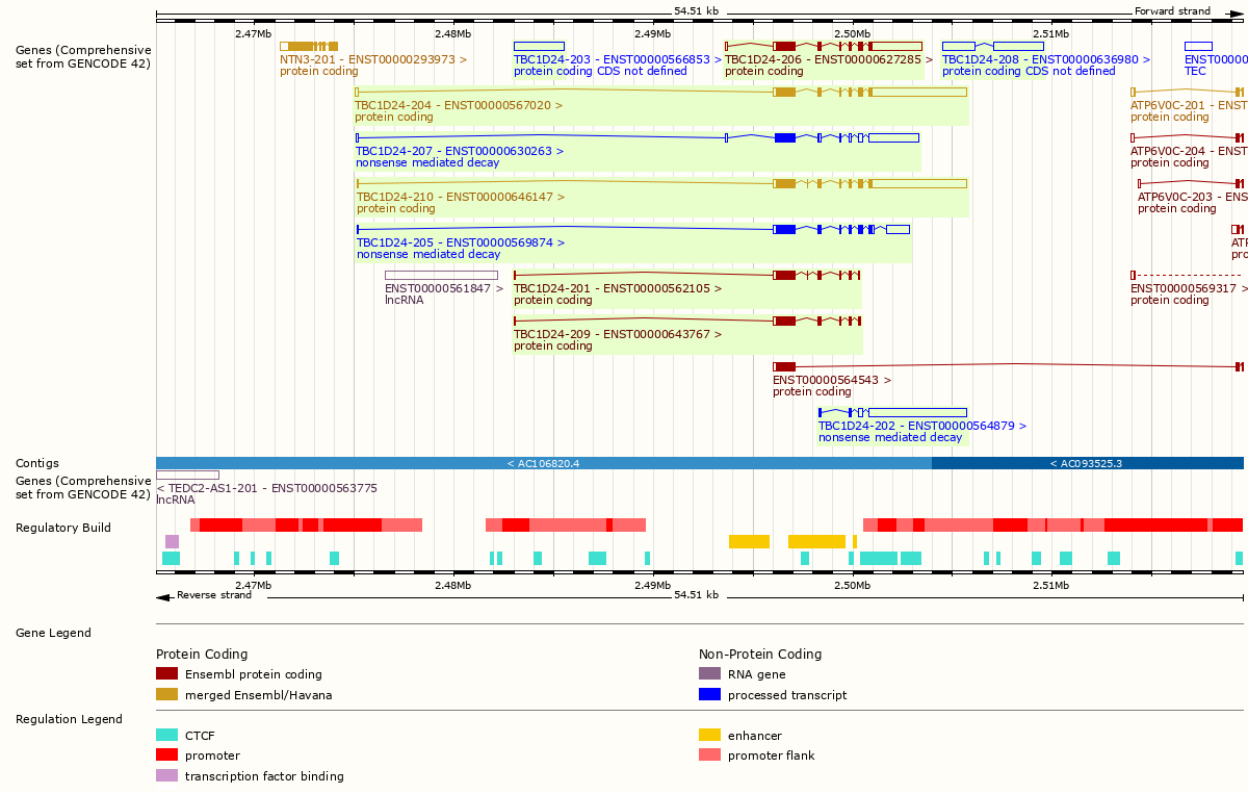

*Gene: CDH23 (ENSG00000107736) - Summary - Homo_Sapiens - Ensembl Genome Browser 108*. useast.ensembl.org/Homo_sapiens/Gene/Summary?db=core;g=ENSG00000107736;r=10:71396920-71815947. Accessed 23 Oct. 2022.

# Gene: STRC ENSG00000242866




*Gene: STRC (ENSG00000242866) - Summary - Homo_Sapiens - Ensembl Genome Browser 108*. useast.ensembl.org/Homo_sapiens/Gene/Summary?db=core;g=ENSG00000242866;r=15:43599563-43618800. Accessed 23 Oct. 2022.

# Gene: TBC1D24 ENSG00000162065




*Gene: TBC1D24 (ENSG00000162065) - Summary - Homo_Sapiens - Ensembl Genome Browser 108*. useast.ensembl.org/Homo_sapiens/Gene/Summary?db=core;g=ENSG00000162065;r=16:2475051-2509560. Accessed 23 Oct. 2022.