

What is meant by the terms “ERB” and “Frequency group”?

Our loudness perception is based on excitation of the basilar membrane found in the inner ear (see Figs. 1 and 2). The human ear processes sounds in parallel, meaning it handles the different sound components simultaneously. This involves breaking down the incoming sound signal into different characteristic frequency bands (known as “frequency groups”) and forming the partial loudness of each frequency group. In the field of psychoacoustics, the loudness impression produced by a sound (or the “overall loudness”) is computed by adding up the partial loudnesses produced in the ERB frequency groups. The unit of the frequency groups is the equivalent rectangular bandwidth (“ERB”). In some cases, the older (and now obsolete) bark scale is used instead of the ERB scale.

Conversion of the physical unit of “frequency” F (in kHz) to the frequency group number (in ERB) is based on the following formula:

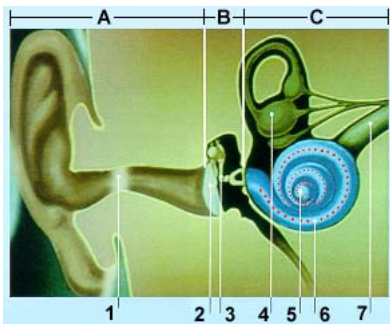
Frequency group number ERB:

$$\text{ERB} = 21.4 \log_{10} (4.37F + 1)$$

The frequency group spacing of an ERB corresponds to a mechanical spacing of approximately 0.89 mm on the human basilar membrane (which has a total length of about 30 mm).

Appendix:

Further reading: Moore, Brian C.J. (publisher): “Hearing”, London 1995, ISBN 0-12-505625-5.



What is meant by the terms “ERB” and “Frequency group”? 1. External auditory canal 2. Eardrum 3. Auditory ossicle (malleus, incus and stapes) 4. Semicircular canals 5. Cochlea 6. Basilar membrane with hair cells 7. Auditory nerve

“Fig. 1 shows a cross-section of our hearing system. The outer ear and external auditory canal are of course familiar to us. They are followed by the eardrum which is a membrane which closes off the external auditory canal with respect to the middle ear. Its movements correspond to the pressure fluctuations which arrive by way of the external auditory canal. These movements are transferred mechanically via the auditory ossicles in the middle ear to the cochlea in the inner ear. The cochlea is about the size of a pea. It contains a liquid and is divided in the longitudinal direction by the basilar membrane. A sound will cause the basilar membrane to begin to vibrate: The highest pitches produce a response at the very front while low pitches penetrate all the way into the cochlea. The

basilar membrane supports the actual “sensors” in the form of about 30,000 hair cells that send electrical pulses to the auditory nerves whenever the basilar membrane is set into motion. The brain can then evaluate these pulses in great detail.”

Source:

<http://www.eurion.ch/Dt/gehoer.htm>

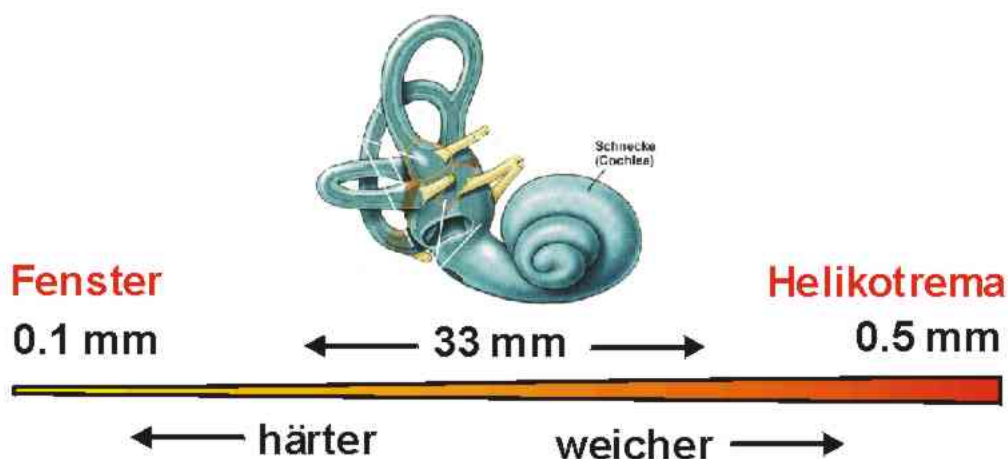


Fig. 2: The cochlea and a schematic representation of the basilar membrane. (see below for source)

“It is possible to imagine the basilar membrane as being like a harp that is tuned across a wide frequency range. The strings that produce high pitches (short, hard, up to 16,000 Hz) are in the base of the cochlea and are close to the windows. The bass strings (long, soft, down to 20 Hz) are close to the tip of the cochlea (the helicotrema). The different physical characteristics are due to the fact that the protein tissue of the basilar membrane in the lower part of the cochlea is thicker and fatter than in the upper part. The dimensions cited above apply to the human basilar membrane.”

Source:<http://www.sinnesphysiologie.de/hvsinne/hoeren/basil.htm> (Stephan Frings, Uni Heidelberg).