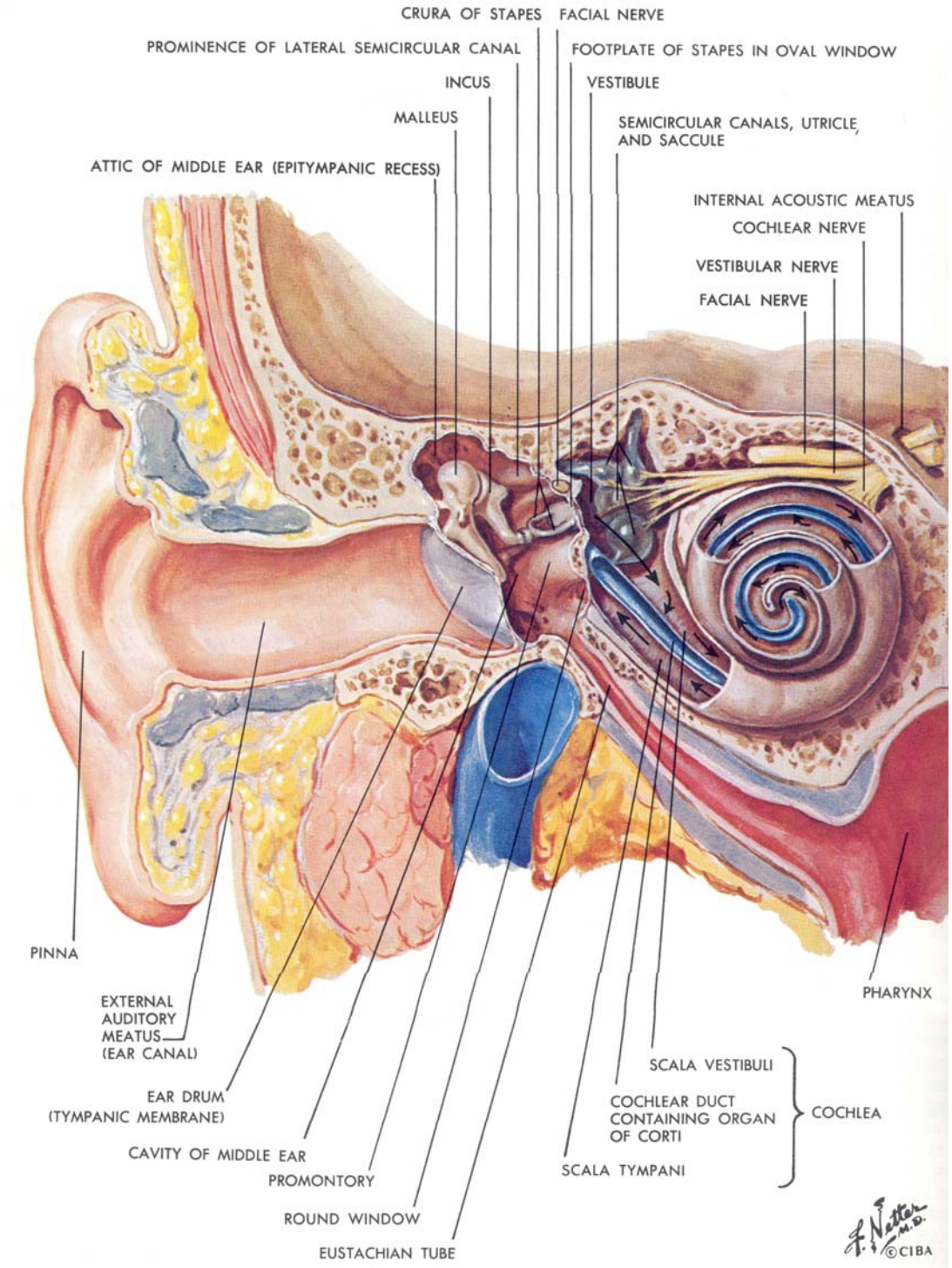

Figure 3.27 Artist's sketch illustrating the anatomy of a human ear (from US NIOSH, 1973).

Define a ***sound pressure level***:

$$\boxed{L_P = 20\log_{10}\left(\frac{P}{P_0}\right)} \tag{3-17}$$

where the term P_0 is a reference value,

$$\boxed{P_0 = 2\times10^{-5}\,\frac{N}{m^2}} \tag{3-18}$$

Define a ***sound intensity level*** (L_I),

$$\boxed{L_I = 10\log_{10}\left(\frac{I}{I_0}\right)} \tag{3-19}$$

where the reference value I_0 corresponds roughly to the reference pressure level (P_0). At STP,

$$\boxed{I_0 = \frac{{P_0}^2}{\rho a} \approx 1\times10^{-12}\,\frac{watt}{m^2}} \tag{3-20}$$

We also define a ***sound power level*** or ***acoustic power level*** (L_W),

$$\boxed{L_W = 10\log_{10}\left(\frac{W}{W_0}\right)} \tag{3-21}$$

where

$$\boxed{W_0 = 1\times10^{-12}\ watt} \tag{3-22}$$

The unit used to express the sound pressure level, sound intensity level, and sound-power level is called the ***decibel*** (dB).

Multiplying each side by 10 and recognizing the definitions of Eqs. **Error! Reference source not found.** and **Error! Reference source not found.**, one obtains

$$\boxed{L_I(r) = L_P(r)} \tag{3-23}$$

It is useful at this point to define a ***reference distance*** (r_0) equal to 1 meter,

$$\boxed{r_0 = 1\ m} \tag{3-24}$$

Then,

$$\boxed{L_I(r) = L_W + 10\log_{10} Q - 11.0 - 20\log_{10}\left(\frac{r}{r_0}\right)} \tag{3-26}$$

or,

$$\boxed{L_P(r) = L_W + 10\log_{10} Q - 11.0 - 20\log_{10}\left(\frac{r}{r_0}\right)} \tag{3-27}$$

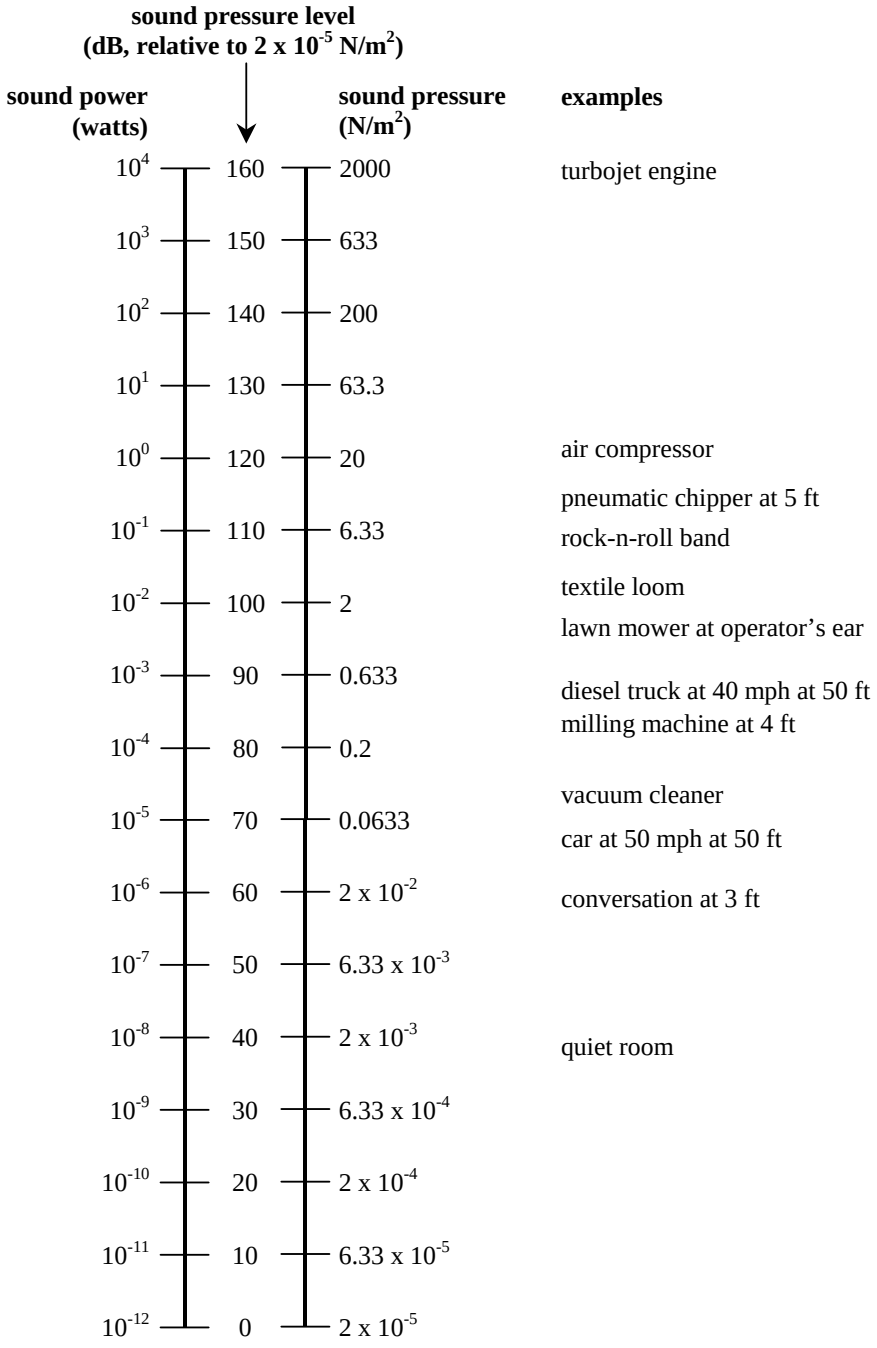

Figure 3.29 Relationship between sound pressure, sound pressure level, and sound power, and some common sources of noise (adapted from US NIOSH, 1973).

Table 3.5 ACGIH and OSHA noise limit standards for the workplace (from Internet websites and US Office of the Federal Register, 1988).

sound intensity (dBA)	**ACGIH exposure time (hr)**	**OSHA exposure time (hr)**
80	24	32
82	16	24.3
85	8	16
88	4	10.6
90	-	8
91	2	7
92	-	6
94	1	4.6
95	-	4
97	0.5	3
100	0.25	2
102	-	1.5
105	-	1
110	-	0.5
115	-	0.25 or less