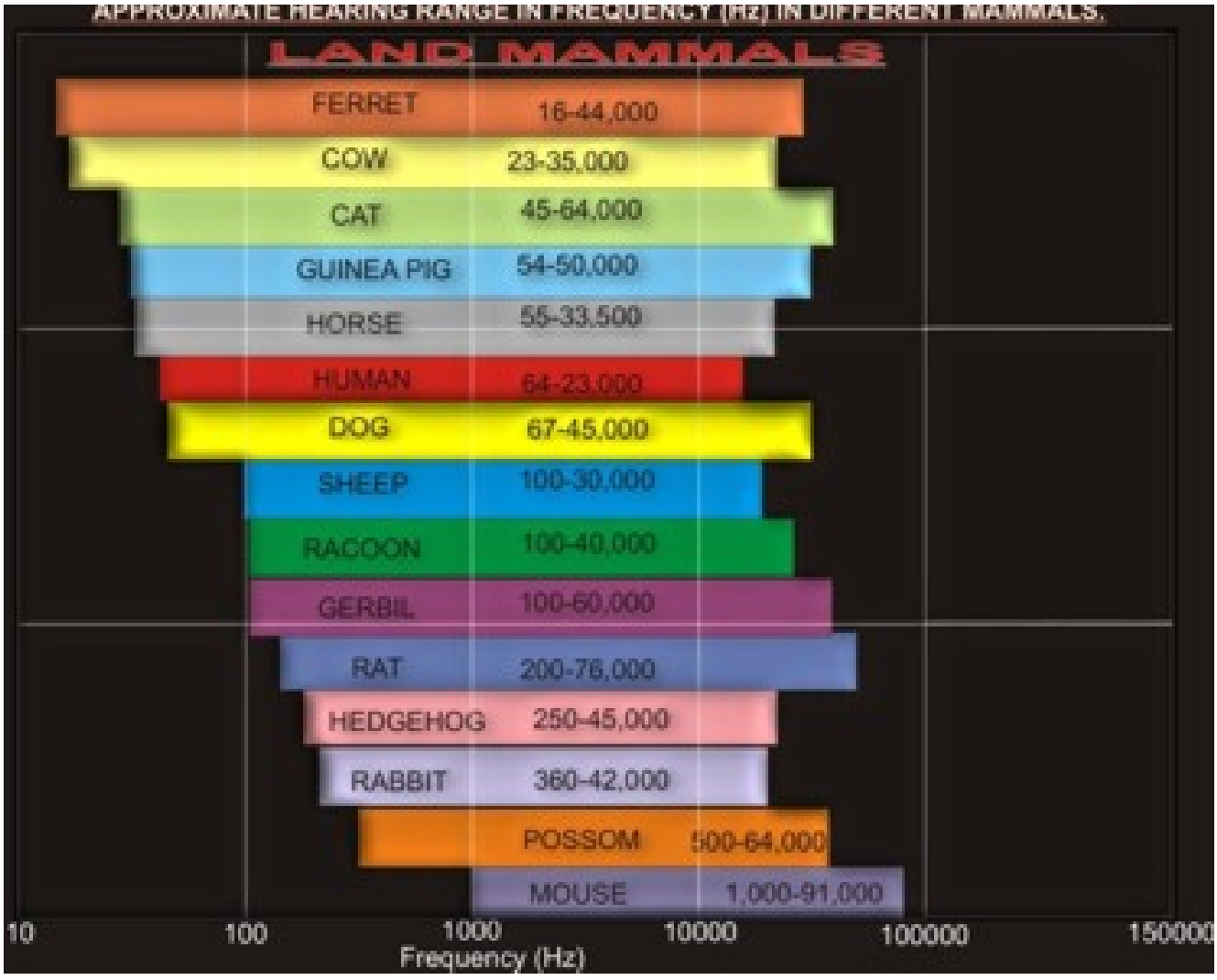
Sensitivity to Sound:

The human ear can detect sound intensities ranging from 1.0 x 10^{-12} W/m^2 (1.0 pW/m^2) all the way up to 1.0 W/m^2, ranging from 0 dB (threshold of sound) all the way to 120 dB (threshold of pain).

This sensitivity is dependant on the frequency of the sound. (see p.470)

We can hear frequencies ranging from 20 Hz to about 20000 Hz, however the ear is most sensitive to frequencies between 1000 Hz and 5000 Hz. Why?

Put another way, if a flute and a tuba were emitting the same intensity, the flute would seem louder to us.


APPROXIMATE HEARING RANGE IN FREQUENCY (HZ) IN DIFFERENT MAMMALS.
LAND MAMMALS
FERRET 16-44,000
COW 23-35,000
CAT 45-64,000
GUINEA PIG 54-50,000
HORSE 55-33,500
HUMAN 64-23,000
DOG 67-45,000
SHEEP 100-30,000
RACOON 100-40,000
GERBIL 100-60,000
RAT 200-76,000
HEDGEHOG 250-45,000
RABBIT 360-42,000
POSSOM 500-64,000
MOUSE 1,000-91,000
10
100
1000
10000
100000
150000
Frequency (Hz)

Intensity (W/m²) | Intensity Level (dB)

$$I = \frac{P}{A}$$

10^{-12} W/m² → 0 dB

1 W/m² → 120 dB

...because the Decibel scale is exponential the intensity of a 10 decibel increase is actually 10 times as great!

So ... 10dB -> 30dB 100 times louder

http://www.egopont.com/hearing_tests.php?soundID=2000 *Test earphones...*

If you are 2.0m away from a 1.0 W/m^2 sound and you then move back to 6.0m, what intensity will you hear?

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$$

**only for Intensity (W/m^2)*

Beats:

Refers to the frequency of a pulsating noise, and not the frequencies of the individual sounds which make up the noise

As the sound waves from each wave travel, the slight frequen variation leads to a pattern of constructive and destructive interference which results in us hearing beats.

$$\text{beat frequency } (f_b) = |(f_2 - f_1)|$$

Example: Calculate the beat frequency when a tuning fork of 440 Hz is sounded with one of 442 Hz.

http://faraday.physics.utoronto.ca/PVB/Harrison/Flash/ClassMechanics/Beats/Beats.html

Homework
Read p. 510
do p. 511 # 1
do p. 515 # 2, 3, 4, 5, 6
do p. 516 # 19, 20, 23