APPENDIX 2

Fundamental Constants, Conversion Factors, and Some Useful Approximations

Fundamental Constants

R (gas constant)	8.314 J(joules) deg^{-1} mol^{-1} 1.987 cal deg^{-1} mol^{-1}
F (Faraday)	96,500 J V^{-1} $(volt)^{-1}$ $equiv^{-1}$ (or coulombs $equiv^{-1}$) 23,060 cal V^{-1} $equiv^{-1}$
N (Avogadro number)	6.02×10^{23} particles mol^{-1}
e (electronic charge)	1.602×10^{-19} coulombs ($= F/N$)

Conversion Factors

0°C = 273 K

1 cal = 4.184 J

1 electron volt (eV) = 23.06 kcal/mol = 96.5 kJ/mol

(Thus, to convert mV to kJ/mol, multiply by 0.0965; to convert to kcal/mol, multiply by 0.0231.)

$2.3RT/F = 59$ mV at 25°C

(Thus, a 10-fold ratio of concentrations at 25°C is equivalent to 59 mV or 1.36 kcal/mol or 5.69 kJ/mol for a univalent ion.)

Some Useful Approximations (for back-of-the-envelope calculations)

Thickness of cell membrane permeability barrier	= 5 nm
Capacity of cell membrane	= 1 $\mu F/cm^2$
Dielectric constant of aqueous fluids	= 80
Dielectric constant of membrane interior (lipids)	= 2–4
Radius of "typical" animal cell	= 20 μm
Radius of human red blood cell	= 5 μm
Surface area of "typical" cell	= 5000 μm^2
Surface area of human red blood cell	= 140 μm^2
Volume of "typical" cell	= 35,000 μm^3 (35 pl)
Volume of human red blood cell	= 90 μm^3 (0.09 pl)
Typical transmembrane potentials	= −60 to −80 mV (See Table 2.2.)
Aqueous diffusion coefficients of metabolites	= $0.5–2 \times 10^{-5}$ cm^2 sec^{-1} (See Table 2.1.)
Permeability coefficients of small hydrophilic permeants across plasma membranes	= 10^{-9} to 10^{-3} cm sec^{-1} (See Table 2.3.)
Single channel conductances	= 4–200 pS (See Table 3.2.)
Turnover numbers of carriers and pumps	= 10–2000 sec^{-1} (See Table 4.2.)