Symbols and Units

α_h, α_m, α_n	transfer rate coefficients (Hodgkin-Huxley model)
β_h, β_m, β_n	- " -
δ_s, δ_v	two-dimensional [m^{-2}] and three-dimensional [m^{-3}] Dirac delta functions
ε	permittivity [F/m]
E	electromotive force (emf) [V]
Θ	conduction velocity (of wave) [m/s]
λ	membrane length constant [cm] ($\sim \sqrt{(r_m/r_i)} = \sqrt{(R_m a/2\rho_i)}$)
μ	magnetic permeability of the medium [H/m = Vs/Am]
μ, μ_0	electrochemical potential of the ion in general and in the reference state [J/mol]
ν	nodal width [µm]
ρ	resistivity [Ωm], charge density [C/m^3]
ρ_i^b, ρ_o^b	intracellular and interstitial bidomain resistivities [kΩ·cm]
ρ_m^b	bidomain membrane resistivity [kΩ·cm]
ρ_t^b	bidomain total tme impedance [kΩ·cm]
ρ_i, ρ_o	intracellular and interstitial resistivities [kΩ·cm]
σ	conductivity [S/m]
σ_i^b, σ_i^b	intracellular and interstitial bidomain conductivities [mS/cm]
σ_i, σ_o	intracellular and interstitial conductivities [mS/cm]
τ	membrane time constant [ms] (= $r_m c_m$ in one-dimensional problem, = $R_m C_m$ in two-dimensional problem)
φ, θ	longitude (azimuth), colatitude, in spherical polar coordinates

Φ	potential [V]
Φ_i, Φ_o	potential inside and outside the membrane [mV]
Φ_{LE}	reciprocal electric scalar potential field of electric lead due to unit reciprocal current [V/A]
Φ_{LM}	reciprocal magnetic scalar potential field of magnetic lead due to reciprocal current of unit time derivative [Vs/A]
Φ, Ψ	two scalar functions (in Green's theorem)
χ	surface to volume ratio of a cell [1/cm]
ω	radial frequency [rad] (= 2πf)
Ω	solid angle [sr (steradian) = m^2/m^2]
a	radius [m], fiber radius [μm]
$\bar{a}$	unit vector
A	azimuth angle in spherical coordinates [°]
A	cross-sectional area [m˛]
$\bar{A}$	magnetic vector potential [Wb/m = Vs/m]
$\bar{B}$	magnetic induction (magnetic field density) [$Wb/m^2 = Vs/m^2$]
$\bar{B}_{LM}$	reciprocal magnetic induction of a magnetic lead due to reciprocal current of unit time derivative [$Wb{\cdot}s/Am^2 = Vs^2/Am^2$]
c	particle concentration [mol/m^3]
$\bar{c}$	lead vector
c_i,c_o	intracellular and extracellular ion concentrations (monovalent ion) [mol/m^3]
c^k	ion concentration of the k^{th} permeable ion [mol/m^3]
c_m	membrane capacitance per unit length [μF/cm fiber length]
C	electric charge [C (Coulomb) = As]
C_m	membrane capacitance per unit area (specific capacitance) [μF/cm˛]
d	double layer thickness, diameter [μm]
d_i,d_o	fiber internal and external myelin diameters [μm]

$d\bar{S}$	outward surface normal
D	Fick's constant (diffusion constant) [$cm^2/s = cm^3/(cm \cdot s)$]
D	electric displacement [C/m^2]
E	elevation angle in spherical coordinates [°]
$\bar{E}$	electric field [V/m]
$\bar{E}_{LE}$	reciprocal electric field of electric lead due to unit reciprocal current [V/Am]
$\bar{E}_{LM}$	reciprocal electric field of magnetic lead due to reciprocal current of unit time derivative [Vs/Am]
F	Faraday's constant [$9.649 \cdot 10^4$ C/mol]
F	magnetic flux [Wb = Vs]
g_K, g_{Na}, g_L	membrane conductances per unit length for potassium, sodium, and chloride (leakage) [mS/cm fiber length]
G_K, G_{Na}, G_L	membrane conductances per unit area for potassium, sodium, and chloride (leakage) [mS/cm^2]
$G_{K\,max}$, $G_{Na\,max}$	maximum values of potassium and sodium conductances per unit area [mS/cm^2]
G_m	membrane conductance per unit area [mS/cm^2]
h	distance (height) [m]
h	membrane thickness [µm]
h, m, n	gating variables (Hodgkin-Huxley model)
Hct	hematocrit [%]
$\bar{H}$	magnetic field [A/m]
$\bar{H}_{LM}$	reciprocal magnetic field of a magnetic lead due to reciprocal current of unit time derivative [s/m]
i_m	membrane current per unit length [µA/cm fiber length] (= $2\pi a I_m$)
i_r	reciprocal current through a differential source element [A]
I	electric current [A]
I_a	applied steady-state (or stimulus) current [µA]

I_i, I_o	axial currents [μA] and axial currents per unit area [μA/cm^2] inside and outside the cell
i_K, i_{Na}, i_L	membrane current carried by potassium, sodium, and chloride (leakage) ions per unit length [μA/cm fiber length]
I_K, I_{Na}, I_L	membrane current carried by potassium, sodium, and chloride (leakage) ions per unit area [μA/cm˛]
I_L	lead current in general [A]
I_m	membrane current per unit area [μA/cm^2] (= $I_{mC} + I_{mR}$), bidomain membrane current per unit volume [μA/cmł]
i_{mC}, i_{mI}, i_{mR}	capacitive, ionic, and resistive components of the membrane current per unit length [μA/cm fiber length] (= $2\pi a I_{mC}$, = $2\pi a I_{mI}$, = $2\pi a I_{mR}$)
I_{mC}, I_{mI}, I_{mR}	capacitive, ionic, and resistive components of the membrane current per unit area [μA/cm˛]
I_r	total reciprocal current [A]
I_{rh}	rheobasic current per unit area [μA/cm^2]
I_s	stimulus current per unit area [μA/cm^2]
j, j_k	ionic flux, ionic flux due to the kth ion [mol/(cm^2·s)]
j_D, j_e	ionic flux due to diffusion, due to electric field [mol/(cm^2·s)]
$\bar{J}$	electric current density [A/m^2]
$\bar{J}\,dv$	source element
$\bar{J}^i$	impressed current density [μA/cm^2], impressed dipole moment per unit volume [μA·cm/cm^3]
$\bar{J}_i$, $\bar{J}_o$	intracellular and interstitial current densities [μA/cm^2]
$\bar{J}^i_F$, $\bar{J}^i_V$	flow (flux) and vortex source components of the impressed current density [μA/cm^2]
$\bar{J}^i_r$, $\bar{J}^i_t$	radial and tangential components of the impressed current density [μA/cm^2]
$\bar{J}_L$	lead field in general [A/m^2]
$\bar{J}_{LE}$	electric lead field due to unit reciprocal current [1/m^2]
$\bar{J}_{LI}$	lead field of current feeding electrodes for a unit current [1/m^2] (in impedance measurement)
$\bar{J}_{LM}$	magnetic lead field due to reciprocal current of unit time derivative [s/m^2]

K	constant
K(k), E(k)	complete elliptic integrals
$\overline{K}_j$	secondary current source for electric fields [μA/cm^2]
l	length [m], internodal spacing [μm]
ℓ	liter
L	inductance [H = Wb/A = Vs/A]
$\overline{m}$	magnetic dipole moment of a volume source [Am^2]
M	vector magnitude in spherical coordinates
M_1, M_2, M_3	peak vector magnitudes during the initial, mid, and terminal phases of the QRS-complex in ECG [mV] and MCG [pT]
n	number of moles
$\overline{n}$	surface normal (unit length)
$\overline{n}_j$	surface normal of surface S_j directed from the primed region to the double-primed one
p	electric dipole moment per unit area [Am/m^2 = A/m]
$\overline{p}$	electric dipole moment of a volume source [Am]
P	pressure [N/m˛]
P_{Cl}, P_K, P_{Na}	membrane permeabilities of chloride, potassium and sodium iones [m/s]
r	radius, distance [m], vector magnitude in spherical polar coordinates
r	correlation coefficient
$\overline{r}$	radius vector
r_i, r_o	axial intracellular and interstitial resistances per unit length [kΩ/cm fiber length] (r_i = $1/\sigma_i \rho a^2$)
r_m	membrane resistance times unit length [kΩ·cm fiber length] (= $R_m/2\rho a$)
R	gas constant [8.314 J/(mol·K)]
R_i, R_o	axial resistances of the intracellular and interstitial media [kΩ]
R_m	membrane resistance times unit area (specific resistance) [kΩ·cm^2]

R_s	series resistance [MΩ]
S_{Cl}, S_K, S_{Na}	electric current densities due to chloride, potassium and sodium ion fluxes [μA/cm^2]
t	time [s]
T	temperature [° C], absolute temperature [K]
u	ionic mobility [cm^2/(V·s)]
v	velocity [m/s]
v	volume [m^3]
V	voltage [V]
V'	deviation of the membrane voltage from the resting state [mV] (= V_m - V_r)
V_c	clamp voltage [mV]
V_L	lead voltage in general [V]
V_{LE}	lead voltage of electric lead due to unit reciprocal current [V]
V_{LM}	lead voltage of magnetic lead due to reciprocal current of unit time derivative [V]
V_K, V_{Na}, V_L	Nernst voltages for potassium, sodium, and chloride (leakage) ions [mV]
V_m	membrane voltage [mV] (= Φ_i - Φ_o)
V_r, V_{th}	resting and threshold voltages of membrane [mV]
V_R	reversal voltage [mV]
V_Z	measured voltage (in impedance measurement) [V]
W	work [J/mol]
X, Y, Z	rectangular coordinates
z	valence of the ions
Z	impedance [Ω]

The *List of Symbols and Units* includes the main symbols existing in the book. Symbols, which appear only in one connection or are obvious extensions of those in the list, are not necessarily included. They are defined in the text as they are introduced.