Ullmann's Encyclopedia of Industrial Chemistry

Fifth, Completely Revised Edition

Volume A 19:
Parkinsonism Treatment to Piezoelectricity

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Volume A 19:
Parkinsonism Treatment to Photoelectricity

Editors: Barbara Elvers, Stephen Hawkins, Gail Schulz

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Symbols and Units

Symbols and units agree with SI standards (for conversion factors see pp. VIII – IX). The following list gives the most important symbols used in the encyclopedia. Articles with many specific units and symbols have a similar list as front matter.

Symbol	Unit	Physical Quantity
a_B		activity of substance B
A_r		relative atomic mass (atomic weight)
A	m^2	area
c_B	mol/m^3, mol/L (M)	concentration of substance B
C	C/V	electric capacity
c_p, c_v	$J\,kg^{-1}K^{-1}$	specific heat capacity
d	cm, m	diameter
d		relative density (ϱ/ϱ_{water})
D	m^2/s	diffusion coefficient
D	Gy (= J/kg)	absorbed dose
e		elementary charge
E	J	energy
E	V/m	electric field strength
E	V	electromotive force
E_A	J	activation energy
f		activity coefficient
F	C/mol	Faraday constant
F	N	force
g	m/s^2	acceleration due to gravity
G	J	Gibbs free energy
h	m	height
h	$W \cdot s^2$	Planck constant
H	J	enthalpy
I	A	electric current
I	cd	luminous intensity
k	(variable)	rate constant of a chemical reaction
k	J/K	Boltzmann constant
K	(variable)	equilibrium constant
l	m	length
m	g, kg, t	mass
M_r		relative molecular mass (molecular weight)
n_D^{20}		refractive index (sodium D-light, 20 °C)
n	mol	amount of substance
N_A	mol^{-1}	Avogadro constant (6.023×10^{23} mol^{-1})
p	Pa; bar*	pressure
Q	J	quantity of heat
r	m	radius
R	$J\,K^{-1}mol^{-1}$	gas constant
R	Ω	electric resistance
S	J/K	entropy
t	s, min, h, d, month, a	time
t	°C	temperature
T	K	absolute temperature
u	m/s	velocity

* The official unit of pressure is the pascal (Pa).

Symbols and units (continued from p. VII)

Symbol	Unit	Physical Quantity
U	V	electric potential
U	J	internal energy
V	m^3, L, mL	volume
w		mass fraction
W	J	work
x_B		mole fraction of substance B
α		cubic expansion coefficient
α	$W m^{-2} K^{-1}$	heat-transfer coefficient (heat-transfer number)
α		degree of dissociation of electrolyte
$[\alpha]$	10^{-2} deg $cm^2 g^{-1}$	specific rotation
η	Pa · s	dynamic viscosity
θ	°C	temperature
$\varkappa$		c_p/c_v
λ	$W m^{-1} K^{-1}$	thermal conductivity
λ	nm, m	wavelength
μ		chemical potential
ν	Hz; s^{-1}	frequency
ν	m^2/s	kinematic viscosity (η/ϱ)
π	Pa	osmotic pressure
ϱ	g/cm^3	density
σ	N/m	surface tension
τ	Pa (N/m^2)	shear stress
φ		volume fraction
χ	Pa^{-1} (m^2/N)	compressibility

Conversion Factors

SI unit	Non-SI unit	From SI to non-SI multiply by
Mass		
kg	pound (avoirdupois)	2.205
kg	ton (long)	9.842×10^{-4}
kg	ton (short)	1.102×10^{-3}
Volume		
m^3	cubic inch	6.102×10^4
m^3	cubic foot	35.315
m^3	gallon (U.S., liquid)	2.642×10^2
m^3	gallon (Imperial)	2.200×10^2
Temperature		
°C	°F	°C × 1.8 + 32
Force		
N	dyne	1.0×10^5

Conversion factors (continued from p. VIII)

SI unit	Non-SI unit	From SI to non-SI multiply by
Energy, Work		
J	Btu (int.)	9.480×10^{-4}
J	cal (int.)	2.389×10^{-1}
J	eV	6.242×10^{18}
J	erg	1.0×10^{7}
J	kW · h	2.778×10^{-7}
J	kp · m	1.020×10^{-1}
Pressure		
MPa	at	10.20
MPa	atm	9.869
MPa	bar	10
kPa	mbar	10
kPa	mm Hg	7.502
kPa	psi	0.145
kPa	torr	7.502

Prefixes for Powers of Ten

E (exa)	10^{18}	M (mega)	10^{6}	d (deci)	10^{-1}	n (nano)	10^{-9}
P (peta)	10^{15}	k (kilo)	10^{3}	c (centi)	10^{-2}	p (pico)	10^{-12}
T (tera)	10^{12}	h (hecto)	10^{2}	m (milli)	10^{-3}	f (femto)	10^{-15}
G (giga)	10^{9}			μ (micro)	10^{-6}	a (atto)	10^{-18}

Abbreviations

The following is a list of the abbreviations used in the text. Common terms, the names of publications and institutions, and legal agreements are included along with their full identities. Other abbreviations will be defined wherever they first occur in an article. For further abbreviations, see p. VII (Symbols and Units), p. XIV (Companies and Country Codes in Patent References). The names of periodical publications are abbreviated exactly as done by Chemical Abstracts Service.

abs.	absolute
a.c.	alternating current
ACGIH	American Conference of Governmental Industrial Hygienists
ACS	American Chemical Society
ADI	acceptable daily intake
ADN	accord européen relatif au transport international des marchandises dangereuses par voie de navigation interieure (European agreement concerning the international transportation of dangerous goods by inland waterways)
ADNR	ADN par le Rhin (regulation concerning the transportation of dangerous goods on the Rhine and all national waterways of the countries concerned)
ADP	adenosine 5'-diphosphate
ADR	accord européen relatif au transport international des marchandises dangereuses par route (European agreement concerning the international transportation of dangerous goods by road)
AEC	Atomic Energy Commission (United States)
AIChE	American Institute of Chemical Engineers

AIME	American Institute of Mining, Metallurgical, and Petroleum Engineers
AMP	adenosine 5'-monophosphate
APhA	American Pharmaceutical Association
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
ATP	adenosine 5'-triphosphate
BAM	Bundesanstalt für Materialprüfung (Federal Republic of Germany)
BAT	Biologischer Arbeitsstoff-Toleranzwert (biological tolerance value for a working material, established by MAK commission, see MAK)
Beilstein	Beilstein's Handbook of Organic Chemistry, Springer, Berlin Heidelberg New York
BET	Brunauer Emmett Teller
BGBl.	Bundesgesetzblatt (Federal Republic of Germany)
BIOS	British Intelligence Objectives Subcommitee Report (see also FIAT)
BOD	biological oxygen demand
bp	boiling point
B.P.	British Pharmacopeia
BS	British Standard
ca.	circa
calcd.	calculated
CAS	Chemical Abstracts Service
cat.	catalyst; catalyzed
cf.	compare
CFR	Code of Federal Regulations (United States)
Chap.	chapter
ChemG	Chemikaliengesetz (Federal Republic of Germany)
C.I.	Colour Index
CIOS	Combined Intelligence Objectives-Subcommitee Report (see also FIAT)
CNS	central nervous system
Co.	Company
COD	chemical oxygen demand
conc.	concentrated
const.	constant
Corp.	Corporation
crit.	critical
CTFA	The Cosmetic, Toiletry and Fragrance Association (United States)
DAB 9	Deutsches Arzneibuch, 9th ed., Deutscher Apotheker-Verlag, Stuttgart 1986
d.c.	direct current
decomp.	decompose, decomposition
DFG	Deutsche Forschungsgemeinschaft (German Science Foundation)
dil.	dilute, diluted
DIN	Deutsche Industrie Norm (Federal Republic of Germany)
DMF	dimethylformamide
DNA	deoxyribonucleic acid
DOE	Department of Energy (United States)
DOT	Department of Transportation Materials Transportation Bureau (United States)
DTA	differential thermal analysis
EC	European Community
ed.	editor, editors, edition, edited
e.g.	for example
emf	electromotive force
EN	European Standard (European Community)
EPA	Environmental Protection Agency (United States)
EPR	electron paramagnetic resonance
Eq.	equation
ESCA	electron spectroscopy for chemical analysis
esp.	especially
ESR	electron spin resonance
Et	ethyl substituent ($-C_2H_5$)
et al.	and others
etc.	et cetera
EVO	Eisenbahnverkehrsordnung (Federal Republic of Germany)
exp (...)	$e^{(\ldots)}$, mathematical exponent
FAO	Food and Agriculture Organization (United Nations)
FDA	Food and Drug Administration (United States)
FD & C	Food, Drug and Cosmetic Act (United States)
FHSA	Federal Hazardous Substances Act (United States)
FIAT	Field Information Agency, Technical (United States reports on the chemical industry in Germany, 1945)
Fig.	figure
fp	freezing point
Friedländer	P. Friedländer, Fortschritte der Teerfarbenfabrikation und verwandter Industriezweige,

	Vol. 1 - 25, Springer, Berlin 1888 - 1942
FT	Fourier transform
(g)	gas, gaseous
GC	gas chromatography
GefStoffV	Gefahrstoffverordnung (regulations in the Federal Republic of Germany concerning hazardous substances)
GGVE	Verordnung in der Bundesrepublik Deutschland über die Beförderung gefährlicher Güter mit der Eisenbahn (regulation in the Federal Republic of Germany concerning the transportation of dangerous goods by rail)
GGVS	Verordnung in der Bundesrepublik Deutschland über die Beförderung gefährlicher Güter auf der Straße (regulation in the Federal Republic of Germany concerning the transportation of dangerous goods by road)
GGVSee	Verordnung in der Bundesrepublik Deutschland über die Beförderung gefährlicher Güter mit Seeschiffen (regulation in the Federal Republic of Germany concerning the transportation of dangerous goods by sea-going vessels)
GLC	gas-liquid chromatography
Gmelin	Gmelin's Handbook of Inorganic Chemistry, 8th ed., Springer, Berlin - Heidelberg - New York
GRAS	generally recognized as safe
Hal	halogen substituent (−F, −Cl, −Br, −I)
Houben-Weyl	Methoden der organischen Chemie, 4th ed., Georg Thieme Verlag, Stuttgart
HPLC	high performance liquid chromatography
IARC	International Agency for Research on Cancer, Lyon, France
IAEA	International Atomic Energy Agency
IATA-DGR	International Air Transport Association, Dangerous Goods Regulations
ICAO	International Civil Aviation Organization
i.e.	that is
i.m.	intramuscular
IMDG	International Maritime Dangerous Goods Code
IMO	Inter-Governmental Maritime Consultive Organization (in the past: IMCO)
Inst.	Institute
i.p.	intraperitoneal
IR	infrared
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry
i.v.	intravenous
Kirk-Othmer	Encyclopedia of Chemical Technology, 3rd ed., J. Wiley & Sons, New York - Chichester - Brisbane - Toronto 1978 - 1984
(l)	liquid
Landolt-Börnstein	Zahlenwerte u. Funktionen aus Physik, Chemie, Astronomie, Geophysik u. Technik, Springer, Heidelberg 1950 - 1980; Zahlenwerte und Funktionen aus Naturwissenschaften und Technik, Neue Serie, Springer, Heidelberg, since 1961
LC_{50}	lethal concentration
LCLo	lowest published lethal concentration
LD_{50}	lethal dose
LDLo	lowest published lethal dose
ln	logarithm (base e)
LNG	liquefied natural gas
log	logarithm (base 10)
LPG	liquefied petroleum gas
M	mol L
M	metal (in chemical formulas)
MAK	Maximale Arbeitsplatz-Konzentration (maximum concentration at the workplace in the Federal Republic of Germany); cf. Deutsche Forschungsgemeinschaft (ed.): Maximale Arbeitsplatzkonzentrationen (MAK) und Biologische Arbeitsstoff-Toleranz-Werte (BAT), VCH Verlagsgesellschaft, Weinheim (published annually)
max.	maximum
MCA	Manufacturing Chemists Association (United States)

Me	methyl substituent ($-CH_3$)
Methodicum Chimicum	Methodicum Chimicum, Georg Thieme Verlag, Stuttgart
MIK	maximale Immissionskonzentration (maximum immission concentration)
min.	minimum
mp	melting point
MS	mass spectrum, mass spectrometry
NAS	National Academy of Sciences (United States)
NASA	National Aeronautics and Space Administration (United States)
NBS	National Bureau of Standards (United States)
NCTC	National Collection of Type Cultures (United States)
NIH	National Institutes of Health (United States)
NIOSH	National Institute for Occupational Safety and Health (United States)
NMR	nuclear magnetic resonance
no.	number
NRC	Nuclear Regulatory Commission (United States)
NRDC	National Research Development Corporation (United States)
NSC	National Service Center (United States)
NSF	National Science Foundation (United States)
NTSB	National Transportation Safety Board (United States)
OECD	Organization for Economic Cooperation and Development
OSHA	Occupational Safety and Health Administration (United States)
p., pp.	page, pages
Patty	G. D. Clayton, F. E. Clayton (eds.): Patty's Industrial Hygiene and Toxicology, 3rd ed., Wiley Interscience, New York
PB report	Publication Board Report (U.S. Department of Commerce, Scientific and Industrial Reports)
PEL	permitted exposure limit
Ph	phenyl substituent ($-C_6H_5$)
Ph. Eur.	European Pharmacopoeia, 2nd. ed., Council of Europe, Strasbourg 1981
phr	part per hundred rubber (resin)
PNS	peripheral nervous system
ppm	parts per million
q. v.	which see (quod vide)
ref.	refer, reference
resp.	respectively
R_f	retention factor (TLC)
R. H.	relative humidity
RID	règlement international concernant le transport des marchandises dangereuses par chemin de fer (international convention concerning the transportation of dangerous goods by rail)
RNA	ribonucleic acid
R phrase (R-Satz)	risk phrase according to ChemG and GefStoffV (Federal Republic of Germany)
rpm	revolutions per minute
RTECS	Registry of Toxic Effects of Chemical Substances, edited by the National Institute of Occupational Safety and Health (United States)
(s)	solid
SAE	Society of Automotive Engineers (United States)
s.c.	subcutaneous
SI	International System of Units
SIMS	secondary ion mass spectrometry
S phrase (S-Satz)	safety phrase according to ChemG and GefStoffV (Federal Republic of Germany)
STEL	Short Term Exposure Limit (see TLV)
STP	standard temperature and pressure (0 °C, 101.325 kPa)
T_g	glass transition temperature
TA Luft	Technische Anleitung zur Reinhaltung der Luft (clean air regulation in Federal Republic of Germany)
TA Lärm	Technische Anleitung zum Schutz gegen Lärm (low noise regulation in Federal Republic of Germany)
TDLo	lowest published toxic dose
THF	tetrahydrofuran
TLC	thin layer chromatography
TLV	Threshold Limit Value (TWA and STEL); published annually by the American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, Ohio
TOD	total oxygen demand
TRK	Technische Richtkonzentration (lowest technically feasible level)
TSCA	Toxic Substances Control Act (United States)

TÜV	Technischer Überwachungsverein (Technical Control Board of the Federal Republic of Germany)
TWA	Time Weighted Average
Ullmann	Ullmanns Encyklopädie der Technischen Chemie, 4th ed., Verlag Chemie, Weinheim 1972–1984; 3rd ed., Urban und Schwarzenberg, München 1951–1970
USAEC	United States Atomic Energy Commission
USAN	United States Adopted Names
USD	United States Dispensatory
USDA	United States Department of Agriculture
U.S.P.	United States Pharmacopeia
UV	ultraviolet
UVV	Unfallverhütungsvorschriften der Berufsgenossenschaft (workplace safety regulations in the Federal Republic of Germany)
VbF	Verordnung in der Bundesrepublik Deutschland über die Errichtung und den Betrieb von Anlagen zur Lagerung, Abfüllung und Beförderung brennbarer Flüssigkeiten (regulation in the Federal Republic of Germany concerning the construction and operation of plants for storage, filling, and transportation of flammable liquids, classification according to the flash point of liquids, recently in accordance with the classification in the United States)
VDE	Verband Deutscher Elektroingenieure (Federal Republic of Germany)
VDI	Verein Deutscher Ingenieure (Federal Republic of Germany)
vol	volume
vol.	volume (of a series of books)
vs.	versus
WHO	World Health Organization (United Nations)
Winnacker-Küchler	Chemische Technologie, Carl Hanser Verlag, München
wt	weight
$	U.S. dollar, unless otherwise stated

Abbreviations for the Names of Frequently Cited Companies

Air Products	Air Products and Chemicals
Akzo	Algemene Koninklijke Zout Organon
Alcoa	Aluminum Company of America
Allied	Allied Corporation
Amer. Cyanamid	American Cyanamid Company
BASF	BASF Aktiengesellschaft
Bayer	Bayer AG
BP	British Petroleum Company
Celanese	Celanese Corporation
Daicel	Daicel Chemical Industries
Dainippon	Dainippon Ink and Chemicals Inc
Dow Chemical	The Dow Chemical Company
DSM	Dutch Staats Mijnen
Du Pont	E.I. du Pont de Nemours & Company
Exxon	Exxon Corporation
FMC	Food Machinery & Chemical Corporation
GAF	General Aniline & Film Corporation
W.R. Grace	W.R. Grace & Company
Hoechst	Hoechst Aktiengesellschaft
IBM	International Business Machines Corporation
ICI	Imperial Chemical Industries
IFP	Institut Français du Pétrole
INCO	International Nickel Company
3M	Minnesota Mining and Manufacturing Company
Mitsubishi Chemical	Mitsubishi Chemical Industries
Monsanto	Monsanto Company
Nippon Shokubai	Nippon Shokubai Kagaku Kogyo
PCUK	Pechiney Ugine Kuhlmann
PPG	Pittsburg Plate Glass Industries
Searle	G.D. Searle & Company
SKF	Smith Kline & French Laboratories
SNAM	Societá Nazionale Metandotti
Sohio	Standard Oil of Ohio
Stauffer	Stauffer Chemical Company
Sumitomo	Sumitomo Chemical Company
Toray	Toray Industries Inc.
UCB	Union Chimique Belge
Union Carbide	Union Carbide Corporation
UOP	Universal Oil Products Company
VEBA	Vereinigte Elektrizitäts- und Bergwerks-AG
Wacker	Wacker Chemie GmbH

Country Codes

The following list contains a selection of standard country codes used in the patent references

AT	Austria	ID	Indonesia
AU	Australia	IL	Israel
BE	Belgium	IT	Italy
BG	Bulgaria	JP	Japan*
BR	Brazil	LU	Luxembourg
CA	Canada	MA	Morocco
CH	Switzerland	NL	Netherlands*
CS	Czechoslovakia	NO	Norway
DD	German Democratic Republic	NZ	New Zealand
DE	Federal Republic of Germany (and Germany before 1949)*	PL	Poland
		PT	Portugal
DK	Denmark	SE	Sweden
ES	Spain	SU	Soviet Union
FI	Finland	US	United States of America
FR	France	YU	Yugoslavia
GB	United Kingdom	ZA	South Africa
GR	Greece	EP	European Patent Office*
HU	Hungary	WO	World Intellectual Property Organization

* For Europe, Federal Republic of Germany, Japan, and the Netherlands, the type of patent is specified: EP (patent), EP-A (application), DE (patent), DE-OS (Offenlegungsschrift), DE-AS (Auslegeschrift), JP (patent), JP-Kokai (Kokai tokkyo koho), NL (patent), and NL-A (application).

Periodic Table of Elements

1A ("European" group designation according to old IUPAC recommendation)
1 (group designation according to 1985 IUPAC proposal)
IA ("American" group designation, also used by the Chemical Abstracts Service until the end of 1986)

																	0 18 VIIIA
1.0079 $_{1}$H	2A 2 IIA											3B 13 IIIA	4B 14 IVA	5B 15 VA	6B 16 VIA	7B 17 VIIA	4.0026 $_{2}$He
6.941 $_{3}$Li	9.0122 $_{4}$Be											10.811 $_{5}$B	12.011 $_{6}$C	14.007 $_{7}$N	15.9994 $_{8}$O	18.998 $_{9}$F	20.180 $_{10}$Ne
22.990 $_{11}$Na	24.305 $_{12}$Mg	3A 3 IIIB	4A 4 IVB	5A 5 VB	6A 6 VIB	7A 7 VIIB	8 8 VIII	8 9 VIII	8 10 VIII	1B 11 IB	2B 12 IIB	26.982 $_{13}$Al	28.086 $_{14}$Si	30.974 $_{15}$P	32.066 $_{16}$S	35.453 $_{17}$Cl	39.948 $_{18}$Ar
39.098 $_{19}$K	40.078 $_{20}$Ca	44.956 $_{21}$Sc	47.88 $_{22}$Ti	50.942 $_{23}$V	51.996 $_{24}$Cr	54.938 $_{25}$Mn	55.847 $_{26}$Fe	58.933 $_{27}$Co	58.69 $_{28}$Ni	63.546 $_{29}$Cu	65.39 $_{30}$Zn	69.723 $_{31}$Ga	72.61 $_{32}$Ge	74.922 $_{33}$As	78.96 $_{34}$Se	79.904 $_{35}$Br	83.80 $_{36}$Kr
85.468 $_{37}$Rb	87.62 $_{38}$Sr	88.906 $_{39}$Y	91.224 $_{40}$Zr	92.906 $_{41}$Nb	95.94 $_{42}$Mo	98.906 $_{43}$Tc *	101.07 $_{44}$Ru	102.91 $_{45}$Rh	106.42 $_{46}$Pd	107.87 $_{47}$Ag	112.41 $_{48}$Cd	114.82 $_{49}$In	118.71 $_{50}$Sn	121.75 $_{51}$Sb	127.60 $_{52}$Te	126.90 $_{53}$I	131.29 $_{54}$Xe
132.91 $_{55}$Cs	137.33 $_{56}$Ba		178.49 $_{72}$Hf	180.95 $_{73}$Ta	183.85 $_{74}$W	186.21 $_{75}$Re	190.2 $_{76}$Os	192.22 $_{77}$Ir	195.08 $_{78}$Pt	196.97 $_{79}$Au	200.59 $_{80}$Hg	204.38 $_{81}$Tl	207.2 $_{82}$Pb	208.98 $_{83}$Bi	208.98 $_{84}$Po *	209.99 $_{85}$At *	222.02 $_{86}$Rn *
223.02 $_{87}$Fr *	226.03 $_{88}$Ra *																

138.91 $_{57}$La	140.12 $_{58}$Ce	140.91 $_{59}$Pr	144.24 $_{60}$Nd	146.92 $_{61}$Pm *	150.36 $_{62}$Sm	151.97 $_{63}$Eu	157.25 $_{64}$Gd	158.93 $_{65}$Tb	162.50 $_{66}$Dy	164.93 $_{67}$Ho	167.26 $_{68}$Er	168.93 $_{69}$Tm	173.04 $_{70}$Yb	174.97 $_{71}$Lu
227.03 $_{89}$Ac *	232.04 $_{90}$Th *	231.04 $_{91}$Pa *	238.03 $_{92}$U *	237.05 $_{93}$Np *	244.06 $_{94}$Pu *	243.06 $_{95}$Am *	247.07 $_{96}$Cm *	247.07 $_{97}$Bk *	251.08 $_{98}$Cf *	252.08 $_{99}$Es *	257.10 $_{100}$Fm *	258.10 $_{101}$Md *	259.10 $_{102}$No *	260.11 $_{103}$Lr *

* Elements with unstable isotopes; mass of most important isotope given

Contents

Cross References

Particle Board → Wood
Particle Size Analysis → 2. Particle Size Analysis, **B2**
Parting Agents → Release Agents
Patents → 12. Information and Documentation, **B1**; → 13. Patents, **B1**
Peanut Oil → Fats and Fatty Oils
Pectin → Polysaccharides
Pencils → Drawing and Writing Materials
Penicillin → Antibiotics
Pentane-2,4-dione → Ketones
Pentanes → Hydrocarbons
Peptic Ulcer Treatment → Antacids and Peptic Ulcer Treatment
Perchloric Acid → Chlorine Oxides and Chlorine Oxygen Acids
Perlite → Silicates
Peroxides → Peroxo Compounds, Inorganic
Peroxycarboxylic acids → Peroxy Compounds, Organic
Pest Control → Acaricides; → Crop Protection; → Insect Control; → Molluscicides; → Nematocides; → Rodenticides
Pet Food → Foods, 1. General Survey
Petrol → Motor Fuels
Petroleum → Resources of Oil and Gas; → Oil, Oil Refining
Petroleum Refining → Oil, Oil Refining
Petroleum Resins → Resins, Synthetic
Petroleum Sulfonates → Sulfonic Acids, Aliphatic and Alkyl Sulfates
Phenanthrene → Hydrocarbons
Phenethyl Alcohol → Flavors and Fragrances
Phenolsulfonic Acids → Benzenesulfonic Acids and Their Derivatives
Phenylalanine → Amino Acids
Phenyl Hydrazine → Hydrazine
Pheromones → Biological Control; → Crop Protection; → Insect Control
Phloroglucinol → Phenol Derivatives
Phosphanes → Phosphorus Compounds, Inorganic
Phosphates, Inorganic → Phosphoric Acid and Phosphates
Phosphates, Organic → Phosphorus Compounds, Organic
Phosphating → Metals, Surface Treatment
Phosphazenes → Inorganic Polymers
Phosphines → Phosphorus Compounds, Organic
Phosphonium Compounds → Phosphorus Compounds, Organic
Phosphorous Acid → Phosphorous Compounds, Inorganic
Phosphors → Luminescent Materials
Phosphorus Oxides → Phosphorus Compounds, Inorganic
Phosphorus Oxychloride → Phosphorus Compounds, Inorganic
Phosphorus Pentasulfide → Phosphorus Compounds, Inorganic
Phosphorus Pentoxide → Phosphorus Compounds, Inorganic
Photocells → Photovoltaic Cells
Photodetectors → Photoelectricity

Parkinsonism Treatment

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1. Introduction

Parkinson's disease (PD) is one of the major degenerative neurological diseases afflicting humans, with a worldwide prevalence exceeding 1 per 1000 population. It is, however, primarily a disease of middle-aged and elderly individuals [1]. Thus, 1% of persons over 50 years of age is a sufferer, and more than 5% of those older than 60 years.

Early diagnosis is important if patients are to be relieved of both early and later symptoms with currently available therapies. Early diagnosis may also postpone development of the more distressing later manifestations of the disease. Although therapy alleviates symptoms, as well as restoring and sustaining a worthwhile quality of life for the patient, it does not appear to retard progression of the disease [2]–[5].

Clinical Diagnostic Criteria. The major clinical diagnostic criteria for PD are tremor, rigidity, akinesia, and bradyphrenia [6], [7]. Depression is the most frequent psychopathologic disorder. Reports on its frequency range from ca. 30 to 90%, strongly supporting the hypothesis that depression in idiopathic PD is due to endogenous neurophysiological defects, particularly a reduction in the level of the neurotransmitter serotonin (5-hydroxytryptamine) in the brain.

Tremor is a major symptom; it usually begins unilaterally, often as the typical "pill-rolling" hand and arm activity. Tremor is present at rest, can be decreased or blocked by conscious will, but is aggravated by stress especially when directed motor actions are attempted.

Rigidity is reported as stiffness and cramplike pains in the limbs. A plastic resistance to passive movement is apparent on examination that, when coexisting with tremor, may appear as a "cogwheel effect".

Akinesia is the inability to translate an intended movement into real activity. The execution of movement is slow and is associated with postural changes in the neck and trunk, as well as a characteristic shuffling gait consisting of small hesitant steps that quicken to prevent falling. Coordinated simultaneous movement of the arms and legs is impossible.

Bradyphrenia is a slowness of cognitive processing associated with apathy, impaired concentration, and finally dementia. It may correlate positively with depression.

Other characteristics of PD are an expressionless masklike face with greasy skin, increased salivation, and impaired swallowing. Handwrit-

ing may become small, and speech difficulties produce a soft, monotonous voice. Sweating attacks, constipation, urinary frequency, and incontinence are not uncommon.

Pathophysiology of Parkinson's Disease. The central nervous system (CNS) defects associated with the development of PD are centered in the paired basal ganglia, including the striatum (caudate nucleus plus putamen), the globus pallidus (pallidum), the subthalamic nucleus, and the substantia nigra (Fig. 1) [8]–[10]. The latter is divided into two regions, the pars compacta and pars reticulata.

The basal ganglia belong to the extrapyramidal tract and are responsible for the transmission of cortical motor signals associated with voluntary movement (→ Neuropharmacology, **A 16**, pp. 140–141). Parkinson's disease is one of a number of extrapyramidal disorders (i.e., neurological disorders) that arise from lesions specifically affecting the basal ganglia. Other extrapyramidal disorders include Huntington's chorea, Wilson's disease, dystonia, dyskinesia, and torticollis. Clinically, they represent combinations of abnormal voluntary movements, and disturbances in postural stability and muscle tone, and are collectively termed movement disorders.

The substantia nigra is severely damaged in PD. The basal ganglia appear to operate together with the cerebellum as interfaces between the cognitive and motor systems of the brain, converting intentions into motor actions. Destruction of any of the components of the basal ganglia, like that which occurs in the substantia nigra in PD, consequently impairs muscle function and control.

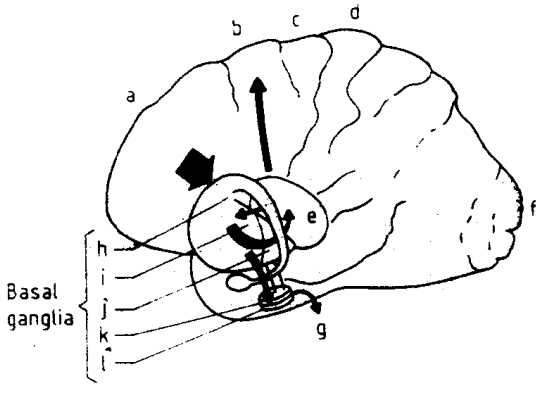

Figure 1. The basal ganglia and some of their connections [11]
a) Prefrontal cortex; b) Premotor cortex; c) Motor cortex; d) Sensory cortex; e) Thalamus; f) Visual cortex; g) Brainstem; h) Striatum (caudate nucleus); i) Striatum (putamen); j) Pallidum; k) Substantia nigra (pars compacta); l) Substantia nigra (pars reticulata)

The nerve fibers of the basal ganglia are parts of input, processing, and output circuits. The input pathway from the cortex to the basal ganglia contains the largest number of neuronal fibers in the basal ganglia system. Input connections run from the cortex to the striatum (Fig. 2). The striatum in turn sends nerve fibers to dopamine-secreting nerve cells (neurons) in the substantia nigra (pars compacta). The dopamine-secreting neurons connect back to cholinergic interneurons in the striatum. The output structures of the striatum include the pallidum and the subthalamic nucleus. From here, nerve fibers project to the motor cortex via the ventrolateral thalamus to complete the overall cortex–basal ganglia–cortex loop. This sophisticated feedback control system works through a finely tuned balance of excitatory and inhibitory neurotransmitters. All the nerve fibers leading from the striatum to the pallidum and from there to the ventrolateral thalamus are in effect inhibitory pathways that secrete the inhibitory transmitter γ-aminobutyric acid (GABA). The circular pathway cortex–basal ganglia–cortex is a feedback loop that is needed to stabilize motor control. Neurotransmission from the striatum to the substantia nigra also involves inhibitory GABA secretion at the substantia nigra nerve terminals.

The darkly staining melanophore cells in the substantia nigra send out nerve axons to the striatum to form the nigrostriatal pathway and employ dopamine as an inhibitory transmitter. Both GABA and dopamine normally control their own respective brain structures unless some disease or lesion specifically damages the pathways in which they are involved.

Another significant source of input to the striatum is the corticostriatal pathway derived from the neocortex that uses glutamate as its neurotransmitter. Glutamate is an important excitatory transmitter within the basal ganglia complex and is thought to be responsible for about half of the total input to the striatum. Acetylcholine, another excitatory neurotransmitter, is secreted from interneurons within the striatum. This interconnected system is maintained in balance via neuronal feedback control loops.

The clinical symptoms of parkinsonism are caused by destruction of the dopaminergic fibers of the darkly staining neuromelanin neurons in

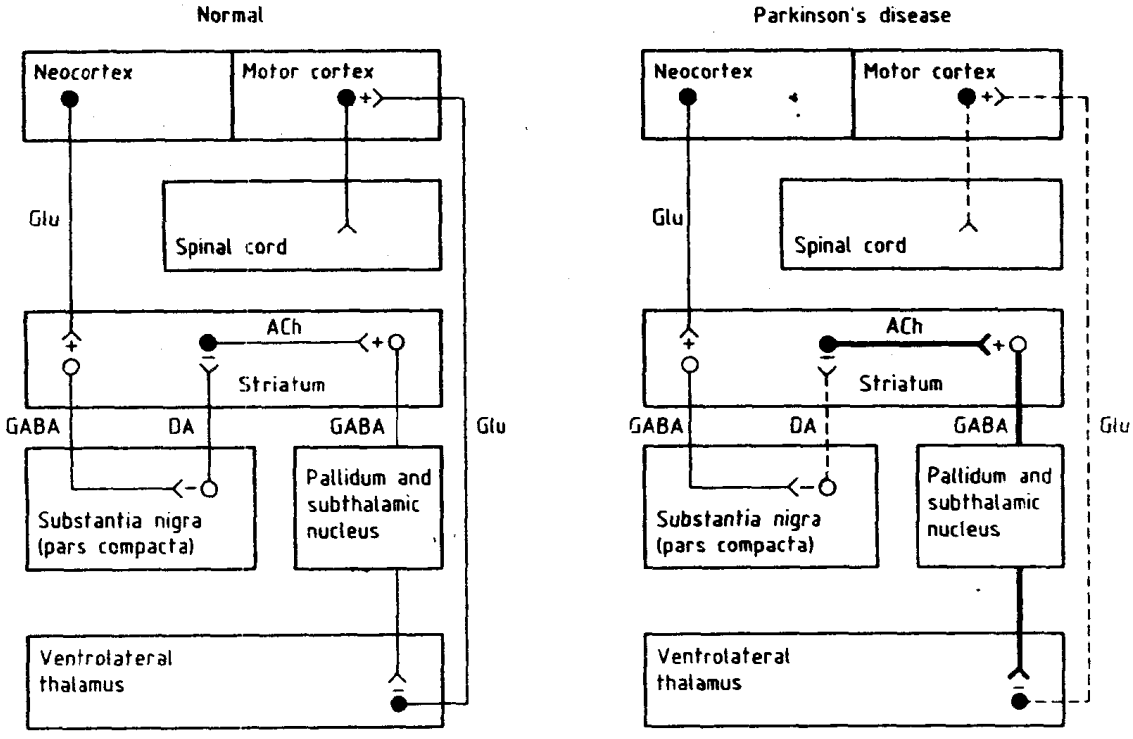

Figure 2. Schematic diagram illustrating the basal ganglia circuitry in normal humans and in patients suffering from Parkinson's disease (PD).

Excitatory (●) and inhibitory (○) neurons are shown with their axons, which form synaptic contacts with other nerve cells (+ excitatory synapse, − inhibitory synapse). Neurotransmitters secreted at the nerve terminals include γ-aminobutyric acid (GABA), dopamine (DA), glutamate (Glu), and acetylcholine (ACh). Broken and thick lines indicate reduced and increased activity, respectively. In PD, dopaminergic neurons of the substantia nigra (pars compacta) are destroyed, resulting in disinhibition (excitation) of cholinergic cells in the striatum. The overactivity of the striatal complex and its increased inhibitory output lead to a marked reduction of the activity of the thalamocortical feedback loop. These mechanisms can explain the symptoms of PD such as tremor, hypokinesia, or akinesia.

the substantia nigra (pars compacta) that project to the striatum (see Figs. 1 and 2). This destruction results in a dopamine deficiency. The cholinergic function in the striatum is simultaneously maintained, leading to an imbalance between inhibitory and excitatory neurotransmitters. A reduction in dopamine levels leads to excessive excitation by acetylcholine, which in turn augments the inhibitory (GABA) output of the striatum. As a consequence, the activity of the thalamocortical feedback loop is markedly reduced, leading to impaired motor function. Parkinson's disease can therefore be regarded as an overactivity of the striatal complex resulting from the loss of the fine control normally exercised by the neuromelanin-producing dopaminergic cells. By the time the first clinical symptoms (e.g., tremor or hypokinesia) become apparent, some 80% of these pigmented substantia nigral cells have already been destroyed.

Etiology of Parkinson's Disease. The cause of parkinsonism is not known with certainty. However, it is probably triggered by some environmental insult in early to middle life. As a result, the pigmented neurons are destroyed much sooner than in normal age-dependent degeneration. Pesticides used in rural areas (e.g., paraquat) may constitute such an environmental insult. However, the disease was known long before it was described by JAMES PARKINSON in 1817; thus, other environmental factors must also be responsible.

A recent hypothesis links PD to lipid oxidation involving excessive formation of oxygen-derived free radicals in the basal ganglia. The free radicals then progressively destroy dopamine-producing neurons under participation of the immune system. Thus, Parkinson's disease is regarded as a failure of scavenger molecules produced by the basal ganglia cells to

neutralize the harmful free radical products. Further acceleration may be caused by the enzyme monoamine oxidase-B (MAO-B), which catalyzes the metabolism of catecholamine neurotransmitters and simultaneously produces reactive oxygen species. Therefore, therapeutic inhibition of MAO-B may also inhibit neurodegeneration in PD. Of major interest in this context is parkinsonism induced by 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine [*28289-54-5*] (MPTP) because of its importance for new in vitro and in vivo pharmacological research models. This comparatively simple molecule selectively destroys dopaminergic cells in the substantia nigra and induces advanced parkinsonian symptoms in humans within a few weeks. Thus, the possibility that an environmental toxin triggers the development of PD appears reasonable.

2. Therapy of Parkinson's Disease

Modern therapy started with the discovery that the brains of Parkinson patients were deficient in dopamine. Dopamine was originally re-

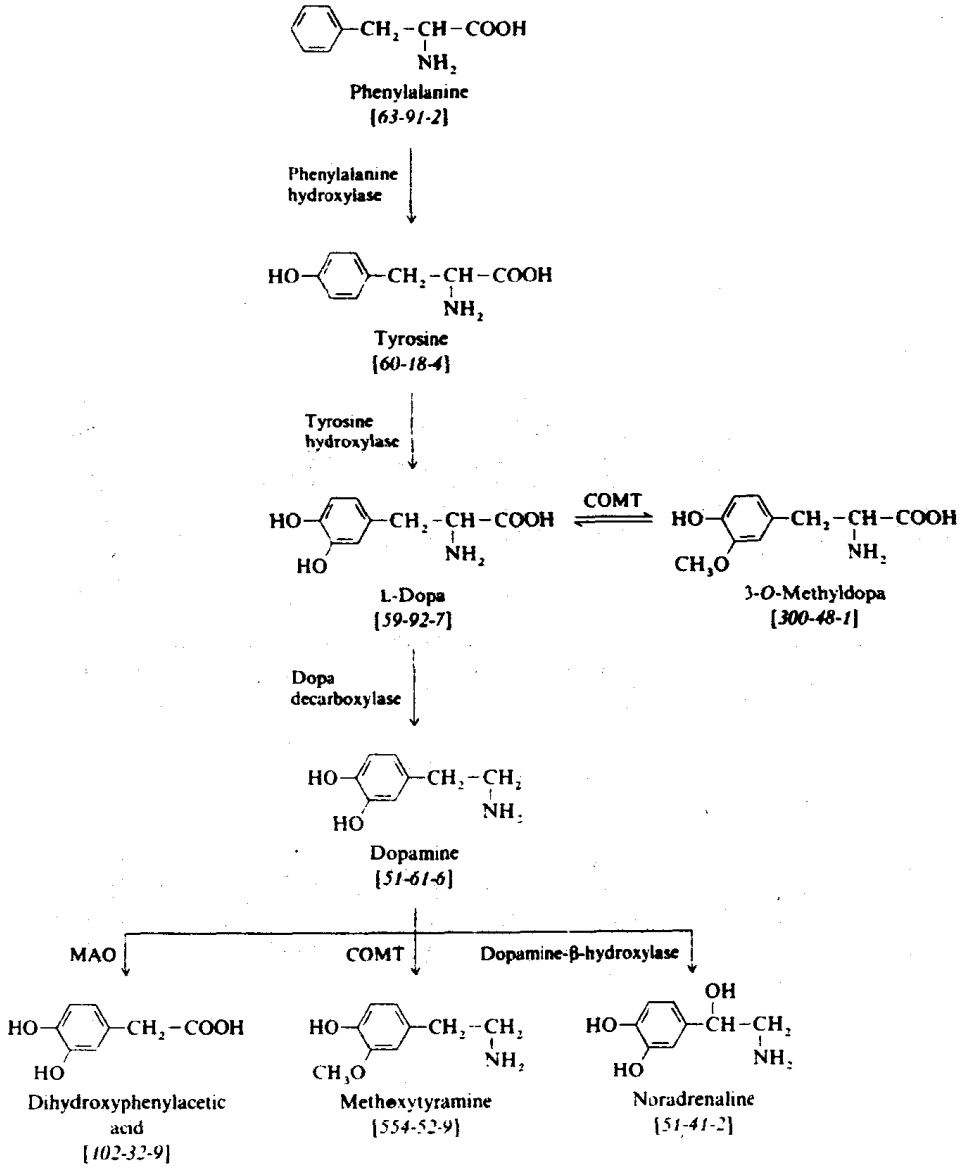

Figure 3. Biosynthesis and metabolism of dopamine
COMT = Catechol-*O*-methyl transferase; MAO = Monoamine oxidase