

Free Radical Nomenclature, Suggestions

Garry R. Buettner, Ph.D. and Freya Q. Schafer, Ph.D.
 Free Radical and Radiation Biology Program
 EMRB 68
 The University of Iowa
 Iowa City, IA 52242-1101

The purpose of this document is to provide an easy reference to some of the language of Free Radical Biology. We provide here a beginning guideline to nomenclature and notation for free radicals and related species. The International Union of Pure and Applied Chemistry (IUPAC) does not provide suggestions on all abbreviations we might use; attached are the suggestions of the FRRB Program. Guidelines for nomenclature in Free Radical Biology can be found in [1, 2, 3, 4, 5 and references therein].

I. Free Radical and Oxidant Notation and Nomenclature

In chemical formulae as well as when using abbreviations, a free radical is denoted by a superscript dot to the right preceding any charge. This placement of the dot will not interfere with indication of mass number, atomic number, or composition.



Table 1. Formulae and IUPAC Recommended Names of Simple Compounds Containing C, H, and O in Free Radical Biology

Species	Common Name	Systematic Name	Alternative and Comments
CO	carbon monoxide	carbon monoxide	oxidomethanediyl
CO ₂	carbon dioxide	carbon dioxide	dioxidomethane
CO ₂ ^{•-}	carbon dioxide radical anion	dioxidocarbonate (•1-)	oxidooxomethyl radical
CO ₃ ^{•-}	carbonate radical	trioxidocarbonate(•1-)	
H [•]	hydrogen atom	monohydrogen(•)	
H ₂ O	water	dihydrogen monoxide	oxidane
H ₂ O ₂	hydrogen peroxide	dihybridodioxide	dioxidane
H ₃ C [•]	methyl radical		
HNO ₂	nitrous acid		
HNO ₃	nitric acid		
HO [•]	hydroxyl radical	hydridooxygen	oxidanyl

HO_2^-		hydridodioxygen (1-)	dioxidanide, hydrogendioxide(1-); hydrogenperoxide(1-); hydroperoxide is not recommended
HO_2^\bullet	hydroperoxyl, but is obsolete	hydridodioxygen(•)	dioxidonyl, hydrodioxyl, perhydroxyl does not make sense
HO_3^\bullet	hydrogen trioxide radical	hydridotrioxxygen(•)	trioxidanyl
HOCO^\bullet		hydroxidooxidocarbon(•)	
HOCO^\bullet_2		hydroxidodioxidocarbon(•)	
HOCl	hypochlorous acid	hydrogenoxidochlorate	
HOBr	hypobromous acid	hydrogenoxidobromate	
HOI	hypoiodous acid	hydrogenoxidoidate	
HOSCN	hypothiocyanous acid	hydrogenoxidothiocyanate	
$\text{HON}^{2\bullet}$		hydroxidonitrogen(2•)(triplet)	hydrogen oxidonitrate(2•)(triplet)
HOOCO		(hydridodioxido)oxidocarbon(•)	
HOONO	peroxynitrous acid	hydrogenoxidoperoxidonitrate	nitrosodioxidane
$(\text{NO})_2^{\bullet-}$		<i>bis</i> (oxidonitrate)(<i>N – N</i>)(•1-)	
N_2O	nitrous oxide	dinitrogen monoxide	
$\text{N}_2\text{O}^{\bullet-}$		oxidodinitrate(•1-)	
N_2O_3	dinitrogen trioxide		
N_3^\bullet	azidyl radical	trinitrogen(2 <i>N – N</i>)(•)	
NO^\bullet	nitric oxide, but is obsolete	oxidonitrogen (•)	oxoazanyl, nitrogen monoxide
$\text{NO}^{(2\bullet)-}$	nitroxyl	oxidonitrate(2•1-) (triplet)	
NO_2^-	nitrite	dioxidonitrate(1-)	
NO_2^\bullet	nitrogen dioxide	dioxidonitrogen	
$\text{NO}_2^{\bullet 2-}$		dioxidonitrate(•2-)	
NO_3^-	nitrate	trioxidonitrate(-)	
NO_3^\bullet	nitrogen trioxide	trioxidonitrogen(•)	nitrosoxidanyl
$\text{NO}_3^{\bullet 2-}$		trioxidonitrate(•2-)	
$\text{O}^{\bullet-}$	radical anion of HO^\bullet	oxide(•1-)	oxidanidyl
$\text{O}_2^{\bullet-}$	superoxide	dioxide(•1-)	dioxidanidyl
$\text{O}_2^{\bullet+}$		dioxygen(•1+)	
$\text{O}_2^{2\bullet}$	oxygen, usually	dioxygen (triplet)	dioxidanediyl

	written as O ₂		
O ₃	ozone	trioxygen	
O ₃ ^{•-}	ozonide	trioxide(•1-)	trioxidanidyl
OCl ⁻	hypochlorite	oxidochlorate(1-)	
OBr ⁻	hypobromite	oxidobromate(1-)	
OI ⁻	hypoiodite	oxidoiodate(1-)	
OSCN ⁻	hypothiocyanate	oxidothiocyanate(1-)	
OCOO ^{•-}		(dioxido)oxidocarbonate(•1-)	
ONOO ⁻	peroxynitrite	oxidoperoxidate(1-)	nitrosodioxidanide
ONOOH	peroxynitrous acid	hydrogen-oxidoperoxynitrate	nitrosodioxidane
ONOO [•]		(dioxido)oxidonitrogen(•)	nitrosodioxidanyl

II. Free Radical Nomenclature You Should Know

Table 2 Common Abbreviations

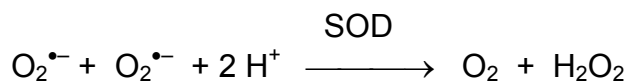
Species/Abbreviation*	Name
Asc; AscH ⁻ ; Asc ^{•-}	ascorbate, general; ascorbate monoanion; ascorbate radical
CAT	catalase
Desferal [®]	trade name for deferoxamine mesylate
DMPO	5,5-dimethyl-pyrroline-1-oxide, a spin trap
DTPA or DETAPAC	diethylenetriaminepentaacetic acid
EDRF	endothelium-derived relaxing factor
EDTA	ethylenediaminetetraacetic acid
EPR	electron paramagnetic resonance
ESR	electron spin resonance, identical with EPR
G	gauss
GPx	glutathione peroxidase
GR	glutathione disulfide reductase; often referred to as glutathione reductase (a misnomer)
Grx	glutaredoxin
GS [•]	glutathionyl radical
GSH	glutathione, not reduced glutathione (a misnomer)
GSSG	glutathione disulfide; not oxidized glutathione (a misnomer)
GST	glutathione S transferase
H ⁺	proton, hydron; not to be confused with H [•]
LDL	low density lipoprotein

MDA	malondialdehyde
NBT	nitroblue tetrazolium
NOS	nitric oxide synthase
$^1\text{O}_2$	singlet oxygen
OH^-	hydroxide anion, not to be confused with HO^\bullet
PBN	α -phenyl-N- <i>tert</i> -butyl nitron, a spin trap
Prx	peroxiredoxin
PhGPx	phospholipid hydroperoxide glutathione peroxidase (GPx-4)
POBN	α -[4-pyridyl 1-oxide]-N- <i>tert</i> -butyl nitron, a spin trap
PUFA	polyunsaturated fatty acid
RO^\bullet	alkoxyl radical; not alkoxy
ROO^\bullet	alkyl dioxygen(\bullet), alkyl dioxyl, alkylperoxyl radical; not peroxy
ROOH	alkyl hydroperoxide
ROS	reactive oxygen species
SOD	superoxide dismutase
CuZnSOD	copper,zinc-superoxide dismutase (SOD-1)
MnSOD	manganese-superoxide dismutase (SOD-2)
FeSOD	iron-superoxide dismutase
ECSOD	extracellular superoxide dismutase (SOD-3)
TBARS	thiobarbituric acid reactive substances
Trx	thioredoxin

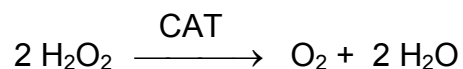
* These are commonly used abbreviations. Others appear in the literature.

III. Enzyme Reactions You Must Know to Understand Free Radical Biology

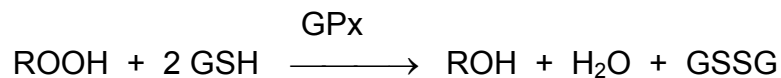
A. The reaction for superoxide dismutase (SOD) is:



B. The reaction for catalase (CAT) is:



C. The reaction for glutathione peroxidase (GPx) is:



where R = H is allowed.

End 2003-01-17

IV. References

- 1 Koppenol WH. (2000) Names for inorganic radicals. *Pure Appl Chem.* **72**:437-446.
- 2 Powell WH. (1993) Revised nomenclature for radicals, ions, radical ions and related species. Found at: <http://www.chem.qmul.ac.uk/iupac/ions> .
- 3 Koppenol WH. (1990) What is in a name? Rules for radicals. *Free Radic Biol. Med* **9**:225-227.
- 4 Trynham JG. (1986) A short guide to nomenclature of radicals, radical ions, iron-oxygen complexes and polycyclic aromatic hydrocarbons. *Adv Free Radic Bio Med.* **2**:191-209.
- 5 Koppenol WH. (2002) NO nomenclature. *Nitric Oxide Biol Chem.* **6**:96-98.