

*PROGRESS IN*

# Nucleic Acid Research and Molecular Biology

*Volume 29*

*Genetic Mechanisms in Carcinogenesis*

*edited by*

WALDO E. COHN

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WALDO E. COHN

*Biology Division  
Oak Ridge National Laboratory  
Oak Ridge, Tennessee*

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## Preface

In the Prefaces to previous volumes comprised (as is this one) of papers presented at a symposium, note was taken of the shift in emphasis from the original thrust of this serial publication—nucleic acid chemistry—to the present concern with the involvement of nucleic acids in a number of fields, including genetics, virology, and immunology, and in this volume carcinogenesis. One now seeks to explain the mechanisms of biological events in terms of the chemistry of the nucleic acids and specifically in terms of that icon of “molecular biology” the double helix, or, perhaps more fundamentally still, hydrogen-bonding and base-pairing. The symposium proceedings clearly fall into this area of interest.

The speakers were researchers whom we would have wished to invite to contribute to this publication even in the absence of such a unifying event as a symposium. Hence the decision was made to ask the participants (and contributors to the parallel “poster” sessions) to submit papers or extended summaries of their presentations for a work devoted to the symposium. This volume is the result.

I would like to announce a change in the editorship of this serial publication. Begun in 1963 with the late J. N. Davidson and me as editors (and as a continuing sequel to the classic three-volume work edited by Chargaff and Davidson, “The Nucleic Acids: Chemistry and Biology”) I continued as sole editor after the untimely death of Davidson in 1972 (see the Obituary in Volume 13, pages xxi–xxiii). With Volume 30, this publication will again have two editors. Kivie Moldave will join me in the effort to maintain the standards set by the preceding volumes.

As stated often in earlier Prefaces, “we seek to provide a forum for discussion . . . and we welcome suggestions . . . as to how this end may best be served.”

WALDO E. COHN

# Abbreviations and Symbols

All contributors to this Series are asked to use the terminology (abbreviations and symbols) recommended by the IUPAC-IUB Commission on Biochemical Nomenclature (CBN) and approved by IUPAC and IUB, and the Editor endeavors to assure conformity. These Recommendations have been published in many journals (1, 2) and compendia (3) in four languages and are available in reprint form from the Office of Biochemical Nomenclature (OBN), as stated in each publication, and are therefore considered to be generally known. Those used in nucleic acid work, originally set out in section 5 of the first Recommendations (1) and subsequently revised and expanded (2, 3), are given in condensed form (I-V) below for the convenience of the reader. Authors may use them without definition, when necessary.

## I. Bases, Nucleosides, Mononucleotides

1. *Bases* (in tables, figures, equations, or chromatograms) are symbolized by Ade, Gua, Hyp, Xan, Cyt, Thy, Oro, Ura; Pur = any purine, Pyr = any pyrimidine, Base = any base. The prefixes S-, H<sub>2</sub>-, F-, Br-, Me-, etc., may be used for modifications of these.

2. *Ribonucleosides* (in tables, figures, equations, or chromatograms) are symbolized, in the same order, by Ado, Guo, Ino, Xao, Cyd, Thd, Ord, Urd ( $\Psi$ rd), Puo, Pyd, Nuc. Modifications may be expressed as indicated in (1) above. Sugar residues may be specified by the prefixes r (optional), d (=deoxyribo), a, x, l, etc., to these, or by two three-letter symbols, as in Ara-Cyt (for aCyd) or dRib-Ade (for dAdo).

3. *Mono-, di-, and triphosphates of nucleosides* (5') are designated by NMP, NDP, NTP. The N (for "nucleoside") may be replaced by any one of the nucleoside symbols given in II-1 below. 2'-, 3'-, and 5'- are used as prefixes when necessary. The prefix d signifies "deoxy." [Alternatively, nucleotides may be expressed by attaching P to the symbols in (2) above. Thus: P-Ado = AMP; Ado-P = 3'-AMP] cNMP = cyclic 3':5'-NMP; Bt<sub>2</sub>cAMP = dibutyl cAMP, etc.

## II. Oligonucleotides and Polynucleotides

### 1. Ribonucleoside Residues

(a) Common: A, G, I, X, C, T, O, U,  $\Psi$ , R, Y, N (in the order of I-2 above).

(b) Base-modified: sI or M for thioinosine = 6-mercaptopurine ribonucleoside; sU or S for thioridine; brU or B for 5-bromouridine; hU or D for 5,6-dihydrouridine; i for isopentenyl; f for formyl. Other modifications are similarly indicated by appropriate lower-case prefixes (in contrast to I-1 above) (2, 3).

(c) Sugar-modified: prefixes are d, a, x, or l as in I-2 above; alternatively, by *italics* or boldface type (with definition) unless the entire chain is specified by an appropriate prefix. The 2'-O-methyl group is indicated by suffix m (e.g., -Am- for 2'-O-methyladenosine, but -mA- for 6-methyladenosine).

(d) Locants and multipliers, when necessary, are indicated by superscripts and subscripts, respectively, e.g., -m<sub>2</sub>A- = 6-dimethyladenosine; -s<sup>4</sup>U- or -s<sup>4</sup>S- = 4-thiouridine; -ac<sup>4</sup>Cm- = 2'-O-methyl-4-acetylcytidine.

(e) When space is limited, as in two-dimensional arrays or in aligning homologous sequences, the prefixes may be placed over the capital letter, the suffixes over the phosphodiester symbol.

### 2. Phosphoric Residues [left side = 5', right side = 3' (or 2')]

(a) Terminal: p; e.g., pppN... is a polynucleotide with a 5'-triphosphate at one end; Ap is adenosine 3'-phosphate; C > p is cytidine 2':3'-cyclic phosphate (1, 2, 3); p < A is adenosine 3':5'-cyclic phosphate.

(b) Internal: hyphen (for known sequence), comma (for unknown sequence); unknown sequences are enclosed in parentheses. E.g., pA-G-A-C(C<sub>2</sub>A,U)A-U-G-C > p is a sequence with a (5') phosphate at one end, a 2':3'-cyclic phosphate at the other, and a tetranucleotide of unknown sequence in the middle. (Only codon triplets should be written without some punctuation separating the residues.)

### 3. Polarity, or Direction of Chain

The symbol for the phosphodiester group (whether hyphen or comma or parentheses, as in 2b) represents a 3'-5' link (i.e., a 5' ... 3' chain) unless otherwise indicated by appropriate numbers. "Reverse polarity" (a chain proceeding from a 3' terminus at left to a 5' terminus at right) may be shown by numerals or by right-to-left arrows. Polarity in any direction, as in a two-dimensional array, may be shown by appropriate rotation of the (capital) letters so that 5' is at left, 3' at right when the letter is viewed right-side-up.

### 4. Synthetic Polymers

The complete name or the appropriate group of symbols (see II-1 above) of the repeating unit, enclosed in parentheses if complex or a symbol, is either (a) preceded by "poly," or (b) followed by a subscript "n" or appropriate number. No space follows "poly" (2, 5).

The conventions of II-2b are used to specify known or unknown (random) sequence, e.g., polyadenylate = poly(A) or A<sub>n</sub>, a simple homopolymer;

poly(3 adenylate, 2 cytidylate) = poly(A<sub>3</sub>C<sub>2</sub>) or (A<sub>3</sub>, C<sub>2</sub>)<sub>n</sub>, an *irregular* copolymer of A and C in 3:2 proportions;

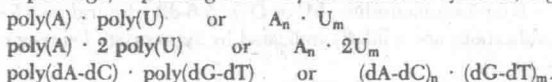
poly(deoxyadenylate-deoxythymidylate) = poly[d(A-T)] or poly(dA-dT) or (dA-dT)<sub>n</sub> or d(A-T)<sub>n</sub>, an *alternating* copolymer of dA and dT;

poly(adenylate, guanylate, cytidylate, uridylate) = poly(A, G, C, U) or (A, G, C, U)<sub>n</sub>, a random assortment of A, G, C, and U residues, proportions unspecified.

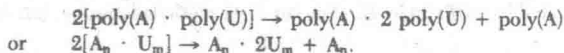
The prefix copoly or oligo may replace poly, if desired. The subscript "n" may be replaced by numerals indicating actual size, e.g., A<sub>n</sub>·dT<sub>12-18</sub>.

## III. Association of Polynucleotide Chains

1. *Associated* (e.g., H-bonded) chains, or bases within chains, are indicated by a *center dot* (not a hyphen or a plus sign) separating the *complete* names or symbols, e.g.:



2. *Nonassociated* chains are separated by the plus sign, e.g.:



3. Unspecified or unknown association is expressed by a comma (again meaning "unknown") between the completely specified chains.

*Note:* In all cases, each chain is completely specified in one or the other of the two systems described in II-4 above.

## IV. Natural Nucleic Acids

RNA	ribonucleic acid or ribonucleate
DNA	deoxyribonucleic acid or deoxyribonucleate
mRNA; rRNA; nRNA	messenger RNA; ribosomal RNA; nuclear RNA
hnRNA	heterogeneous nuclear RNA
D-RNA; cRNA	"DNA-like" RNA; complementary RNA

mtDNA	mitochondrial DNA
tRNA	transfer (of acceptor or amino-acid-accepting) RNA; replaces sRNA, which is not to be used for any purpose
aminoacyl-tRNA	"charged" tRNA (i.e., tRNA's carrying aminoacyl residues); may be abbreviated to AA-tRNA
alanine tRNA or tRNA <sup>Ala</sup> , etc.	tRNA normally capable of accepting alanine, to form alanyl-tRNA; etc.
alanyl-tRNA or alanyl-tRNA <sup>Ala</sup>	The same, with alanyl residue covalently attached. [Note: fMet = formylmethionyl; hence tRNA <sup>fMet</sup> , identical with tRNA <sup>Met</sup> ]
Isoacceptors are indicated by appropriate subscripts, i.e., tRNA <sub>1</sub> <sup>Ala</sup> , tRNA <sub>2</sub> <sup>Ala</sup> , etc.	

### V. Miscellaneous Abbreviations

P <sub>i</sub> , PP <sub>i</sub>	inorganic orthophosphate, pyrophosphate
RNase, DNase	ribonuclease, deoxyribonuclease
<i>t<sub>m</sub></i> (not <i>T<sub>m</sub></i> )	melting temperature (°C)

Others listed in Table II of Reference 1 may also be used without definition. No others, with or without definition, are used unless, in the opinion of the editor, they increase the ease of reading.

### Enzymes

In naming enzymes, the 1978 recommendations of the IUB Commission on Biochemical Nomenclature (4) are followed as far as possible. At first mention, each enzyme is described either by its systematic name or by the equation for the reaction catalyzed or by the recommended trivial name, followed by its EC number in parentheses. Thereafter, a trivial name may be used. Enzyme names are not to be abbreviated except when the substrate has an approved abbreviation (e.g., ATPase, but not LDH, is acceptable).

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5. "Nomenclature of Synthetic Polypeptides," *JBC* **247**, 323 (1972); *Biopolymers* **11**, 321 (1972); and elsewhere.†

### Abbreviations of Journal Titles

Journals	Abbreviations used
Annu. Rev. Biochem.	ARB
Arch. Biochem. Biophys.	ABB
Biochem. Biophys. Res. Commun.	BBRC

\*Contractions for names of journals follow.

†Reprints of all CBN Recommendations are available from the Office of Biochemical Nomenclature (W. E. Cohn, Director), Biology Division, Oak Ridge National Laboratory, Box Y, Oak Ridge, Tennessee 37830, USA.

Biochemistry	Bchem.
Biochem. J.	BJ
Biochim. Biophys. Acta	BBA
Cold Spring Harbor Symp. Quant. Biol.	CSHSQB
Eur. J. Biochem.	EJB
Fed. Proc.	FP
Hoppe-Seyler's Z. physiol. Chem.	ZpChem
J. Amer. Chem. Soc.	JACS
J. Bacteriol.	J. Bact.
J. Biol. Chem.	JBC
J. Chem. Soc.	JCS
J. Mol. Biol.	JMB
Nature, New Biology	Nature NB
Nucleic Acid Research	NARes
Proc. Nat. Acad. Sci. U.S.	PNAS
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