PROGRESS IN

Nucleic Acid Research and Molecular Biology

Volume 26

DNA: Multiprotein Interactions

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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List of Contributors

Numbers in parentheses indicate the pages on which the authors' contributions begin.

S. L. ADHYA (103), *Laboratory of Molecular Biology, National Cancer Institute, Bethesda, Maryland 20205*

D. P. ALLISON (49), *Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

CORRIE T. M. ANDERSON (197), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University, Stanford, California 94305*

A. T. ANNUNZIATO[1] (135), *Department of Zoology, University of Massachusetts, Amherst, Massachusetts 01003*

KEN-ICHI ARAI (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

NAOKO ARAI (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

KIYOZO ASADA (33), *Institute for Chemical Research of Kyoto University, Uji-shi, Japan*

LEROY BERTSCH (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

LARRY E. BOCKSTAHLER (303), *Bureau of Radiological Health, Food and Drug Administration, Rockville, Maryland 20857*

THOMAS BONURA (197), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University, Stanford, California 94305*

JOHN CAIRNS (237), *The Imperial Cancer Research Fund, London N.W. 7, England*

A. CHESTIER (151), *Department of Molecular Biology, Pasteur Institute, 75015 Paris, France*

RICHARD CONE (197), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University, Stanford, California 94305*

PRISCILLA K. COOPER (181), *Department of Biological Sciences, Stanford University, Stanford, California 94305*

S. K. DAS (49), *Biology Division, Oak Ridge National Laboratory, and The University of Tennessee–Oak Ridge Graduate School of Biomedical Sciences, Oak Ridge, Tennessee 37830*

RAYMOND DEVORET (251), *Radiobiologie Cellulaire, Laboratoire d'Enzymologie, C.N.R.S., 91190 Gif-sur-Yvette, France*

[1] Present address: Department of Cellular Biology, Scripps Clinic and Research Foundation, 10666 N. Torrey Pines Road, La Jolla, California 92037.

LORI A. DODSON (227), *Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

KATHLEEN M. DOWNEY (83), *Howard Hughes Medical Institute Laboratory, Departments of Medicine and Biochemistry and Center for Blood Diseases, University of Miami School of Medicine, Miami, Florida 33101*

PAUL A. FISHER (63), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University School of Medicine, Stanford, California 94305*

D. J. FLUKE (315), *Zoology Department, Duke University, Durham, North Carolina 27706*

ERROL C. FRIEDBERG (197), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University, Stanford, California 94305*

R. K. FUJIMURA (1, 49, 99), *Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

S. GARGES (103), *Laboratory of Molecular Biology, National Cancer Institute, Bethesda, Maryland 20205*

PHILIP C. HANAWALT (181), *Department of Biological Sciences, Stanford University, Stanford, California 94305*

YUKINORI HIROTA (33), *National Institute of Genetics, Yata 1,111 Mishima-shi, Japan*

ULRICH HÜBSCHER (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

ROBERT M. IRBE (281), *The Public Health Research Institute of New York, New York, New York 10016*

M. KATINKA (151), *Department of Molecular Biology, Pasteur Institute, 75015 Paris, France*

DENO KAZANIS (315), *Zoology Department, Duke University, Durham, North Carolina 27706*

JOAN KOBORI (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

DAVID KORN (5, 63), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University School of Medicine, Stanford, California 94305*

ARTHUR KORNBERG (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

NANCY B. KUEMMERLE (227), *Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

MARIETTA Y. W. TSANG LEE (83), *Howard Hughes Medical Institute Laboratory, Departments of Medicine and Biochemistry and Center for Blood Diseases, University of Miami School of Medicine, Miami, Florida 33101*

I. R. LEHMAN (265), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

ROBERT LOW (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

WARREN E. MASKER (227), *Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

K. MCENTEE (265), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

LEE M. E. MORIN (281), *The Public Health Research Institute of New York, New York, New York 10016*

G. MOYNE[2] (151), *Department of Molecular Biology, Pasteur Institute, 75015 Paris, France*

AKIKO NISHIMURA (33), *National Institute of Genetics, Yata 1,111 Mishima-shi, Japan*

MICHIO OISHI (281), *The Public Health Research Institute of New York, New York, New York 10016*

ATSUHIRO OKA (33), *Institute for Chemical Research of Kyoto University, Uji-shi, Japan*

LAURIEN POLDER (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

ERNEST C. POLLARD (315, 325), *Zoology Department, Duke University, Durham, North Carolina 27706*

ERIC H. RADANY (197), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University, Stanford, California 94305*

RICHARD J. REYNOLDS[3] (197), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University, Stanford, California 94305*

PETER ROBINS (237), *The Imperial Cancer Research Fund, London N.W. 7, England*

B. C. ROOP (49), *Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830*

WILLIAM J. RUTTER (171), *Department of Biochemistry and Biophysics, University of California, San Francisco, California 94143*

S. SARACOSTI (151), *Department of Molecular Biology, Pasteur Institute, 75015 Paris, France*

RONALD L. SEALE (121, 123), *Scripps Clinic and Research Foundation, La Jolla, California 92037*

[2] Present address: Institut de Recherches, Scientifiques sur le Cancer, B.P. 8, 94800 Villejuif, France.

[3] Present address: Department of Physiology, Harvard School of Public Health, Boston, Massachusetts 02115.

BARBARA SEDGWICK (237), *The Imperial Cancer Research Fund, London N.W. 7, England*

ERLING SEEBERG (217), *Norwegian Defence Research Establishment, Division for Toxicology, N-2007, Kjeller, Norway*

JOSEPH SHLOMAI (9), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

CHARLES ALLEN SMITH (181), *Department of Biological Sciences, Stanford University, Stanford, California 94305*

ANTERO G. SO (83), *Howard Hughes Medical Institute Laboratory, Departments of Medicine and Biochemistry, University of Miami School of Medicine, Miami, Florida 33101*

KAZUNORI SUGIMOTO (33), *Institute for Chemical Research of Kyoto University, Uji-shi, Japan*

MITSURU TAKANAMI (33), *Institute for Chemical Research of Kyoto University, Uji-shi, Japan*

PHILLIPA TALMUD (237), *The Imperial Cancer Research Fund, London N.W. 7, England*

CHENG-KEAT TAN (83), *Howard Hughes Medical Institute Laboratory, Departments of Medicine and Biochemistry and Center for Blood Diseases, University of Miami School of Medicine, Miami, Florida 33101*

TERESA S.-F. WANG (63), *Laboratory of Experimental Oncology, Department of Pathology, Stanford University School of Medicine, Stanford, California 94305*

D. F. WARD (103), *Laboratory of Molecular Biology, National Cancer Institute, Bethesda, Maryland 20205*

G. M. WEINSTOCK (265), *Department of Biochemistry, Stanford University School of Medicine, Stanford, California 94305*

EVELYN M. WITKIN (247), *Department of Biological Sciences, Douglass College, Rutgers University, New Brunswick, New Jersey 08903*

C. L. F. WOODCOCK (135), *Department of Zoology, University of Massachusetts, Amherst, Massachusetts 01003*

MASAO YAMADA (33), *National Institute of Genetics, Yata 1,111 Mishima-shi, Japan*

M. YANIV (151), *Department of Molecular Biology, Pasteur Institute, 75015 Paris, France*

Preface

As the Preface to Volume 1 (1963) indicated, this serial publication was conceived by its two original editors (the late J. H. Davidson and the undersigned) as "a continuing periodical assessment or reassessment of those areas of knowledge in the field of nucleic acids [and, a bit later, in the field of molecular biology] that have arisen or advanced notably since the publication in 1960 of the last of the three volumes of *The Nucleic Acids: Chemistry and Biology*, edited by Chargaff and Davidson." The preponderant interest in chemistry, including enzymology, at that time is shown by the fact that all but one of the eleven articles in Volume 1 dealt with the properties of nucleic acids or with the enzymes that form them. While this basic interest in the chemistry of nucleic acids and of their precursors and analogues has been retained in the 25 volumes that have since appeared, the growth of interest in the functioning and involvement of nucleic acids in biological phenomena—such as genetics, virology, and immunology—has led to an increase in contributions in those areas. The general thrust has been to explain the phenomena in terms of chemical mechanisms, these in turn stemming from the chemical properties of the nucleic acids themselves.

Whatever nucleic acids do in replication or specification of protein (translation) is done in conjunction with proteins, whether the presumably structural proteins of the ribosomes, or the polymerases or ligases or "factors" involved in transcription or translation, and we find many papers in these volumes dealing with protein–nucleic acid interactions. One aspect of the involvement of complexes of nucleic acids and proteins was explored intensively at a recent symposium entitled "DNA–Multiprotein Interactions in Transcription, Replication, and Repair," which was divided into the following sessions: Replicative DNA Polymerase and Its Complex; Mechanisms of Transcription; Chromatin Transcription and Replication; Control of Transcription in Eukaryotes; Mechanisms of DNA Repair; and Functions Induced by Damaged DNA. Those selected by the organizers to present papers were among those research leaders whom we would have been pleased to invite to present extended papers in their respective fields, so it was arranged to present the proceedings in this special, separate volume. Its form, therefore, differs somewhat from that of the typical volume, which would contain a small number of longer contributions on diverse subjects, but if each section is viewed as a multiauthored survey of its particular

area, the difference is not as great as a cursory inspection of the Table of Contents might suggest.

Comments and suggestions from readers are desired. As stated in an earlier Preface, "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_2, 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 (Ψrd), 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_2cAMP = dibutyryl cAMP, etc.

II. Oligonucleotides and Polynucleotides

1. Ribonucleoside Residues

(a) Common: A, G, I, X, C, T, O, U, Ψ, 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 thiouridine; 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_2^6A- = 6-dimethyladenosine; -s^4U- or -^{4}S- = 4-thiouridine; -ac^4Cm- = 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$_2$,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_n, a simple homopolymer;

poly(3 adenylate, 2 cytidylate) = poly(A_3C_2) or $(A_3,C_2)_n$, an *irregular* copolymer of A and C in 3 : 2 proportions;

poly(deoxyadenylate-deoxythymidylate) = poly[d(A-T)] or poly(dA-dT) or $(dA\text{-}dT)_n$ or $d(A\text{-}T)_n$, an *alternating* copolymer of dA and dT;

poly(adenylate,guanylate,cytidylate,uridylate) = poly(A,G,C,U) or $(A,G,C,U)_n$, 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., $A_n \cdot dT_{12\text{-}18}$.

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.:

poly(A) · poly(U) or $A_n \cdot U_m$
poly(A) · 2 poly(U) or $A_n \cdot 2U_m$
poly(dA-dC) · poly(dG-dT) or $(dA\text{-}dC)_n \cdot (dG\text{-}dT)_m$.

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

$2[\text{poly(A)} \cdot \text{poly(U)}] \rightarrow \text{poly(A)} \cdot 2\ \text{poly(U)} + \text{poly(A)}$
or $2[A_n \cdot U_m] \rightarrow A_n \cdot 2U_m + A_n$.

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 (or 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 $tRNA^{Ala}$, etc.	tRNA normally capable of accepting alanine, to form alanyl-tRNA, etc.
alanyl-tRNA or alanyl-$tRNA^{Ala}$	The same, with alanyl residue covalently attached. [*Note:* fMet = formylmethionyl; hence $tRNA^{fMet}$, identical with $tRNA_f^{Met}$]

Isoacceptors are indicated by appropriate subscripts, i.e., $tRNA_1^{Ala}$, $tRNA_2^{Ala}$, etc.

V. Miscellaneous Abbreviations

P_i, PP_i	inorganic orthophosphate, pyrophosphate
RNase, DNase	ribonuclease, deoxyribonuclease
t_m (not T_m)	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).

References*

1. *JBC* **241**, 527 (1966); *Bchem* **5**, 1445 (1966); *BJ* **101**, 1 (1966); *ABB* **115**, 1 (1966), **129**, 1 (1969); and elsewhere.†
2. *EJB* **15**, 203 (1970); *JBC* **245**, 5171 (1970); *JMB* **55**, 299 (1971); and elsewhere.†
3. "Handbook of Biochemistry" (G. Fasman, ed.), 3rd ed. Chemical Rubber Co., Cleveland, Ohio, 1970, 1975, Nucleic Acids, Vols. I and II, pp. 3–59.
4. "Enzyme Nomenclature" [Recommendations (1978) of the Nomenclature Committee of the IUB]. Academic Press, New York, 1979.
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
Proc. Soc. Exp. Biol. Med.	PSEBM
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Viral Inhibition of Host Protein Synthesis
A. SHATKIN

Ribosomal Proteins: Structure and Function
A. R. SUBRAMANIAN

RNA-Helix Destabilizing Proteins
W. SZER AND J. O. THOMAS

Contents