Commission on Biophysical Chemistry: An Introduction

The Commission on Biophysical Chemistry is a recent addition to the Physical Chemistry Division of IUPAC. It came into existence on 1 January 1996. As the chairman of this new Commission I welcome the opportunity to write an introductory note for Chemistry International. By way of introduction it is probably appropriate to give some historical background.

In 1975, IUPAC, IUB and IUPAB decided to create an inter-union Commission on Biothermodynamics. Ingemar Wadsö was chairman and G.T. Armstrong (USA), R.L. Biltonen (USA), J.T. Edsall (USA), H. Gutfreund (UK), W.P. Jencks (USA) and P. Privalov (USSR) were members of this commission. The aim of the commission was to produce guidelines for nomenclature and terminology in the field of biothermodynamics and to organize scientific meetings to this end. In 1985 the Commission on Biothermodynamics was replaced by a ‘Working Party on Biophysical Chemistry’ which somewhat later was renamed ‘Steering Committee on Biophysical Chemistry’ (SCBC). This committee was incorporated in the Physical Chemistry Division of IUPAC and given a wider range of responsibilities. It reported to the Physical Chemistry Division Committee, but remained independent in as much as it was not attached to any of the com-

Prof. Helmut Hauser

missions of the Physical Chemistry Division. Ingemar Wadsö, who chaired the former Commission on Biothermodynamics during most of the time of its existence, continued as chairman of the SCBC. Under his guidance a number of biophysically and biochemically oriented projects were initiated and successfully conducted. Working Parties were established to deal with diverse projects such as 'Electrochemical Biosensors' (coordinator: Katsumi Niki), 'Guidelines for Preparation, Characterization and Terminology Concerning Vesicles' (coordinator: Lisbeth Ter-Minassian-Saraga), 'Protein Stability' (coordinator: Brigitte Heinritz), 'Guidelines for Measurements of Redox Potentials of Proteins' (coordinated by Katsumi Niki and carried out as a joint project with the Commission on Electrochemistry), and 'Standardization of Data Bases on Protein Structures Determined by NMR in Solution' (coordinated by Kurt Wüthrich).

When Ingemar Wadsö resigned from the SCBC in 1991, the author was elected chairman of the SCBC. At that time IUPAC's role and service to the chemical society, both industrial and academic, was being questioned, sometimes criticized, and the need for reorientation and restructuring of the Union became clear and was recognized within IUPAC. It was easily foreseeable that the general trend of applying physics and chemistry to problems in biological areas would not only continue but would substantially increase in the future. The working party on 'Hot Spots in Physical Chemistry' created by the Physical Chemistry Division Committee in 1989 delivered two reports in 1991 emphasizing the importance of biophysical chemistry. As a mater of fact, biophysical chemistry was identified as one of the most importanat fields to focus on in the future. All the members of the SCBC were firmly convinced of this fact. We also knew that we were working on timely projects of immediate interest. Most of our members felt that this kind of effort should be stepped up and intensified within IUPAC in the future. The idea of converting the SCBC to an ordinary commission was born. At the General Assembly in Lisbon in 1993, the SCBC submitted a memo to Robert Alberty, then President of the Physical Chemistry Division, urging him to officially propose to the IUPAC Bureau the conversion of our Steering Committee to a regular commission. An official application was filed under Kozo Kuchitsu who succeeded Alberty as President. It took a great deal of effort, intuition, persistency and persuasion as well as the full support of Kozo Kuchitsu, Bob Alberty, Gus Somsen, Mostafa El-Sayed, Ian Mills and other members of the Physical Chemistry Division Committee before our application was approved by the Council at the General Assembly at Guildford in August 1995 and the SCBC was eventually transformed to a regular commission in the beginning of 1996.

The objectives of this new commission, officially now called 'The Commission on Biophysical Chemistry' (Commission 1.7), as laid down in the terms of reference are:

1 To alert the scientific community to the importance of the application of physicochemical methods to biological problems.

2 To highlight areas related to biophysical chemistry where there is confusion regarding definitions, nomenclature, symbols, and related matters and to establish guidelines and recommendations.

3 To establish contacts with other IUPAC bodies with the aim of initiating interdisciplinary joint projects related to biophysical chemistry.

4 To promote communication between the Physical Chemistry Division and other bodies dealing with biology such as IUPAB and IUBMB that deal with biochemistry, biophysics and molecular biology.

5 To contribute to future IUPAC activities in biologically related areas.

These terms of reference were presented and approved of at the IUPAC General Assembly in Guildford in August 1995. The creation of a Commission on Biophysical Chemistry is undoubtedly based on the conviction that the effort within IUPAC on biologically oriented areas will be increasing in the future. Our members also identified the need of alerting other commissions of the Physical Chemistry Division and also other IUPAC Divisions to problems in biology, biochemistry and biophysics. The aim is certainly to help to initiate biological programmes within these commissions and/or as interdisciplinary joint projects between commissions, as proposed in points 3–5 of the terms of reference.

Our commission was created at times of financial constraints which is reflected in the limited number of Titular Members. To start with our commission had three Titular Members: Robert N. Goldberg (USA), who has been vice chairman and secretary, Helmut Hauser (Switzerland), who has been chairman, and Kurt Wüthrich (Switzerland), and six Associate Members: Martin Caffrey (USA), Athel Cornish-Bowden (France), David Eisenberg (USA), Wilfred van Gunsteren (Switzerland), Wolfram Saenger (Germany) and Akiyoshi Wada (Japan). Our proposal to raise the number of Associate Members to nine was granted by the IUPAC Bureau at the end of 1995. Accordingly, Teizo Kitagama (Japan), Terry R. Stouch (USA) and Daniel R. Thevenot (France) joined our commission as Associate Members in the beginning of 1996. Our commission competed successfully for pool Titular Members, and as a result Fred M. Hawkridge, Hans-Jurgen Hinz and Frederick P. Schwarz were assigned to our commission as short-term Titular Members beginning of 1996. Our request for an extension of the terms of these three Titular Members was granted by the IUPAC Bureau in September 1996 so that these three Titular Members will be associ-

ated with our commission until 31 December 1999.

Current activities of the Commission on Biophysical Chemistry are focused on the following IUPAC Programmes:

I 'Electrochemical Biosensors' is coordinated by Daniel Thevenot and a joint project with the Commissions on Electrochemistry and Biotechnology.

II 'Thermodynamics of Enzyme-Catalyzed Reactions' is coordinated by Robert N. Goldberg and Yadu B. Tewari and is a joint project with the Commission on Thermodynamics. The aim of this project was to provide a critical compilation of data on the thermodynamics of enzyme-catalyzed reactions. The data presented were limited to the results of direct equilibrium and calorimetric measurements performed on these reactions under in vitro conditions. This project led to the publication of three major reviews in the Journal of Physical and Chemical Reference Data: 'Thermodynamics of enzyme-catalyzed reactions: Part 3. Hydrolases', *J. Phys. Chem. Ref. Data* 1994, 23, 1035–1103; 'Thermodynamics of enzyme-catalyzed reactions: Part 4. Lyases', *ibid.* 1995, 24, 1669–1698; and 'Thermodynamics of enzyme-catalyzed reactions: Part 5. Isomerases and Ligases', *ibid.* 1995, 24, 1765–1801.

III The project 'Terminology in the Field of Lipid Vesicles (Liposomes): Preparation and Essential Characterization' was initiated and, as mentioned before, originally coordinated by Lisbeth Ter-Minassian-Saraga. After her retirement from the SCBC in 1991 it has been coordinated by Helmut Hauser and run as a joint project with the Commissions on Colloid and Surface Chemistry including Catalists and Biotechnology.

IV 'Standardization of Data Basis on Protein Structures Determined by NMR in Solution' has been coordinated by Kurt Wüthrich. The final document entitled 'Recommendations for the Presentation of NMR Structures of Proteins and Nucleic Acids' is scheduled to appear in the August issue of *Pure and Applied Chemistry*.

V 'Measurements of Redox Potentials of Proteins' is being carried out in collaboration with the Commissions on Thermodynamics and Electrochemistry. It is coordinated by George S. Wilson and Frederick M. Hawkridge, one of our short-term Titular Members.

VI The project 'A Nomenclature for Lipid Mesophases' was initiated at the General Assembly in Lisbon and is coordinated by Martin Caffrey.

VII 'Recommendations for the Measurement and for the Presentation of Results obtained on Biological Substances with Scanning Calorimetry' was initiated as a joint project with the Commission on Thermodynamics 1994. It is coordinated by Fred P. Schwarz and Hans-Jurgen Hinz who were assigned to this project from the pool of short-term Titular Members.

The first publication submitted recently by our new commission is Kurt Wüthrich's document on the presentation of NMR solution structures. To my mind this project is an example of good and timely service to the chemical community. Solution-state NMR spectroscopy has become an important method of structure determination. Richard Ernst and Kurt Wüthrich of the Swiss Federal Institute of Technology are responsible for the development of the methodology in this field, and needless to say that Kurt Wüthrich is an acknowledged authority in the structure determination by NMR. The method has been used widely in the last decade to determine the structures of peptides, proteins and nucleic acids as well as complexes of peptides and proteins with nucleic acids and other molecules such as, for instance, drugs. A certain consensus has evolved concerning the presentation of NMR solution structures. This has been helped along by issuing guidelines for depositing primary data as well as final structures in protein and nucleic acid data banks and by conventions used by abstracting services. Considering the ever-increasing number of NMR solution structures published in the 1980s, the time appeared to be ripe for the development of generally accepted guidelines for unified nomenclature and reporting standards. With these goals in mind Kurt Wüthrich organized a Working Party (Task Group) as an IUPAC/IUBMB/IUPAB inter-union venture. The project has been supported financially by ICSU and CODATA. The final result of the project is a set of recommendations pertaining to the presentation of NMR data and structures in scientific journals and to the storage of this information in computer-accessible form. This information, in standardized formats, will be freely available to the scientific community. The standardization is important since it is a prerequisite for data exchange. In the course of this project initiated in 1989 the Task Group of eight people has been reviewing previous recommendations of the Nomenclature Committee of IUBMB and IUPAC-IUBMB Joint Commission on Biochemical Nomenclature *(Newsletter* 1992, *Biochem. Int.* 1992, **26**, 567–575) and the Commission on Molecular Structure and Spectroscopy *(Pure Appl. Chem.* 1972, **29**, 627–628, and *Pure Appl. Chem.* 1976, **45**, 219) and has then extended these recommendations in the light of recent developments in the field of biomolecular NMR spectroscopy. This work resulted in several drafts of the recommendations to be issued. These drafts were examined critically by about 50 experts in the field, and were then subjected to two rounds of extensive changes. Modifications and amendments were introduced by the Task Group according to the criticisms and suggestions made by these experts to produce the final document of recommendations.

Regarding the future prospects of our commission we feel that an important assignment given to the members of this commission is to participate in future IUPAC activities in biologically related areas and to contribute to these activities (point 5 of the terms of reference). In this respect our commission may play more than just an ad-

visory role. I believe that the Commission on Biophysical Chemistry is very well equipped for this important task. Our members are chemists who have spent a significant proportion if not a lifetime on research in biological areas. It is this experience that counts and makes all the difference. Future recruitment of members will certainly take care of this point. We need scientists with hand-on experience in research in the life sciences. As the chairman of the Commission on Biophysical Chemistry I would prefer to work on fewer projects in the future than is customary at the moment. I am convinced that what may be called alibi project is not only questionable in terms of usefulness, but is really counterproductive. It is our aim to focus on projects which are very carefully selected and thoroughly screened for what they are worth to the chemical society. To work on fewer projects ensures that our limited resources remain carefully focused. We look forward to close and fruitful contacts and collaborations with other IUPAC bodies. After completing a IUPAC project we regard it as a good sign if the people involved in the work have a convincing and good answer to the final question: Who cares?

IUPAC-IUBMB Joint Commission on Biochemical Nomenclature (JCBN) and Nomenclature Committee of IUBMB (NC-IUBMB)

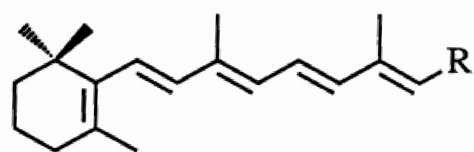
The following are extracts taken from the JCBN and NC-IUBMB joint 1996 newsletter, prepared for publication by Prof. Claude Liébecq, Université de Liège, Belgium.

Vitamin A and retinoids

A document has been prepared by Fritz Weber in consultation with Henry B.F. Dixon and other members of our committees. It has already been published by Fritz Weber (chairman of the former Committee II.1 on Nutritional Terminology of the International Union of Nutritional Sciences) and Athel J. Cornish-Bowden (chairman of our committees) (*Br. J. Nutr.* **74**, 869–870). It is reprinted by permission of the chairman of the Editorial Board of the *British Journal of Nutrition.*

The term ‘vitamin A’ has been defined as the generic descriptor for all C_{20}-β-ionone derivatives that exhibit qualitatively the biological activity of *all-trans* retinol. The term ‘provitamin A’ for the carotenoids giving rise to vitamin A is retained.

Chemically, vitamin A belongs to the ‘retinoids’, defined as a class of compounds consisting of four isoprenoid units joined in a head-to-tail manner. These recommendations also contain the statement: all retinoids may be formally derived from a monocyclic parent compound containing five carbon–carbon double bonds and a functional group at the end of the acyclic portion (Formula I).



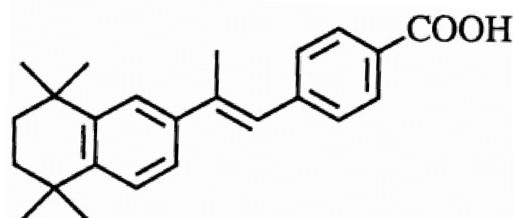
Formula I: Structure of the parent compound of retinoids

The two definitions do not contradict each other. There are, however, certain implications in the words ‘vitamin A’ and ‘retinoids’ that should be considered when using the terms.

‘Vitamin A’ means a group of substances (retinol, retinyl esters, and retinal) with defined biological activities. Further, there are certain metabolites of vitamin A, such as *all-trans* and *cis*-isomeric retinoic acids, that can perform some, but not all, of the biological functions of vitamin A; they are incapable of being metabolically converted into retinol, retinal, etc.

Retinoic acid and some of its isomers and derivatives, together with a number of structurally modified retinoids, have been shown to control cell differentiation in many epithelial tissues and to prevent metaplasia. Some of these substances are used in the treatment of various types of keratinization disorders. Such compounds cannot substitute for vitamin A; indeed some of them even act as vitamin A antagonists.

The term ‘retinoids’ is widely employed for this class of compounds. This practice arose from an earlier proposal to use the name ‘retinoids’ collectively for both natural forms and synthetic analogues of vitamin A that are capable of preventing the development of cancer. General usage of this term is, however, misleading for two reasons. Firstly, the customary practice gives the name ‘retinoids’, which has an agreed definition based on chemical structure, to a class of compounds defined by their biological activity. Secondly, many synthetic members of this class of compounds, the so-called ‘arotinoids’ or ‘retinoidal benzoic acid derivatives’ as well as others, are not chemically retinoids. They contain, e.g. aromatic rings replacing either the basic β-ionone type ring structure or unsaturated bonds of the



Formula II: Structure of an ‘arotinoid’

tetraene side chain of the retinoid skeleton (Formula II).

We now suggest that the compounds that control epithelial differentiation and prevent metaplasia, without possessing the full range of activities of vitamin A, should be termed 'retinoate analogues'. Although they are usually called 'retinoids', we discourage their designation by a term that has a defined, but different, meaning.

A new term for the group of substances with such antimetaplastic activities may be desirable, especially if it is based on their biological activity. It should not imply a chemical structure because of heterogeneity among the compounds. Proposals for such a term are welcome.

Glycosaminoglycans and proteoglycans

Nomenclature (including abbreviations and acronyms) of glycosaminoglycans (GAG) and proteoglycans (PG) is *ad hoc*.

Older terms such as chondroitin sulfates A, B, or C define major tissue components, but difficulties now occur as hybrid polymers from many tissues do not fit in this system; domain structures present in many tissue GAG are not recognized, and the spectra of modifications due to sulfation and 5-epimerization of D-glucuronic acid (D-GlcA) provide no basis on which to distinguish between, for example, chondroitin and dermatan sulfates (CS and DS). If 10% iduronate (L-IdoA) qualifies chondroitin sulfate to be called dermatan sulfate, are chondroitin sulfate containing 9% iduronate and dermatan sulfate containing 11% iduronate different species?

It is proposed that terminology be based on disaccharide units, which are readily accessible to quantitative analysis, via enzymic digestion. These units are of unambiguous composition and can, for example, be represented by logical abbreviations.

Polymer abbreviations could be two-letter codes, e.g. CS, DS, HS (heparan sulfate) and KS (keratan sulfate). If there is no sulfation, Ch, De, Hp and Ke could be used. They are defined in terms of disaccharide units, thus Ch (chondroitan) is the disaccharide polymer $[-4\text{GlcA}\beta1\text{-}3\text{GalNAc}\beta1\text{-}]_n$, where GlcA is D-glucuronate and GalNAc is *N*-acetyl-D-galactosamine.

DS (currently an abbreviation for dermatan sulfate) consists of not only chondroitin sulfate disaccharides, containing D-glucuronate, but also its 5-epimer, L-iduronate. Probably all 'DS' contains chondroitin sulfate units. In order to avoid confusion about definitions of dermatan sulfate, which imply the complete epimerization of D-GlcA to L-IdoA, the term 'dermochondan sulfate' is proposed, indicating that 'DS' preparations are co-polymeric. The abbreviation 'DS' could be retained for these polymers.

Keratan sulfate consists of repeating -3Galβ1-4GlcNAcβ1- units, sulfated to various extents and in different positions. It belongs to the same polymer group as chondroitin sulfate.

Heparan sulfate is the sulfated polymer of heparan (Hp). Heparan consists of a polymer of the following two disaccharides: -4GlcAβ1-4GlcNAcα1- and -4IdoAα1-4GlcNAcα1-. It is therefore analogous to dermchondan sulfate in containing two uronic acid epimers. There are no names analogous to dermatan or chondroitin in this GAG family.

The abbreviation PG for proteoglycan is in wide use. A rational system should convey information about the protein and the glycan parts. Single names purporting to describe both are certain to confuse, since one part is a gene product and the other is introduced by a post-translational modification. They do not necessarily occur together. It is consistent to use proteochondroitan sulfate (PCS), proteokeratan sulfate (PKS), and now proteodermochondan sulfate (PDS) as abbreviations for proteoglycans with chondroitin sulfate, keratan sulfate or dermatan sulfate chains, respectively. If more than one type of glycosaminoglycan chain is attached to the protein, it is expressed, for example, as P(CS,KS) or P(CS,HS), the dominant GAG being written first. This convention can include quantitative or semi-quantitative information about the GAG, accommodating information on numbers of GAG chains attached to the protein, e.g. $\text{P}(\text{CS}_{70\text{-}100}, \text{KS}_{10\text{-}20}, \text{DS}_{7\text{-}10})$.

Protein cores may be viewed as gene products, as amino-acid sequences, as functioning units, or as characteristic shapes (sizes).

Names such as decorin, lumican, aggrecan, syndecan, etc., have been given over the past few years to molecules whose chemistry was known in detail. The names lack chemical information, are inconsistent and should only be used to name the direct gene product.

To emphasize their connection with the gene, rather than with the glycan, the ending 'on' (as in exon, intron, codon) could replace existing 'an', etc. Thus decoron, lumicon, aggrecon, syndecon. A proteoglycan is indicated by adding appropriate GAG abbreviations, e.g. decoron DS, lumicon KS, aggrecon CS,KS.

This complex area of biochemistry would benefit from a structured attempt to rationalize the nomenclature. Comments on the ideas presented here and other suggestions would be welcomed by the nomenclature committees and by John E. Scott of the Department of Chemical Morphology, University of Manchester, Oxford Road, Manchester, M13 9PL, UK (Fax: +44 161 275 4598. E-mail: scott@fs1.ed.man.ac.uk).

The use of 'biochemical equations'

A panel on biochemical thermodynamics, sponsored by JCBN and convened by Robert A. Alberty, has produced a series of recommendations for nomenclature

and tables in biochemical thermodynamics. This report emphasizes the distinction between ‘chemical equations’, in which the full ionic states of all reacting species should be given in a balanced equation, and ‘biochemical equations’. The full charges are often omitted from the equations in routine biochemical presentations. For example, an equation of the form

ATP + acetate = acetyl phosphate + ADP

is commonly used in biochemistry. It makes no attempt to show the full ionization or complexation states or the reactants or to balance charges. It has the advantage that it is written in terms of sums of species and leads directly to the expression for the apparent equilibrium constant K'

$$K' = \frac{\text{[acetyl phosphate][ADP]}}{\text{[ATP] [acetate]}}$$

which is a function of pH and magnesium ion concentration, as well as T, P and ionic strength. In the above biochemical equation, ATP, ADP and acetyl phosphate are obviously sums of species and, if K' is determined at low pH values, acetate represents the sum of the anion and undissociated acetic acid.

Similarly, it has become common to use NAD^+ and NADH in equations, although both of these are in fact negatively charged at normal physiological pH values, without any attempt to balance charges and hydrogen atoms on other species in the equation. This may make it hard to tell whether a chemical equation or a biochemical equation is intended. In view of such difficulties, the panel has recommended that all indications of charges be removed from biochemical equations and that the full chemical equations, which are written in terms of individual species which may be charged (e.g. H^+, Mg^{2+}, $RCOO^-$, etc.) should be used for those specific cases where thermodynamic behaviour is to be considered.

In writing biochemical equations, it is necessary to use symbols that suggest sums of species and avoid symbols for only one of the species that may be present. Since both chemical equations and biochemical equations are need in biochemistry it is important that the reader should be able to distinguish between these two types of equations at a glance. Failure to make such a clear distinction can lead to hybrid equations that do not have corresponding equilibrium constant expressions and have incorrect stoichiometry. For example, the hydrolysis of 1 mol of ATP to ADP at approximately pH 7 does not produce 1 mol of H^+, as suggested by the equation

ATP + H_2O = ADP + phosphate + H^+

but about 0.6 mol. Thus it is recommended that hybrid equations, in which some charges but not others are given, should be avoided as misleading.

The implementation of such recommendations would have substantial implications for the way we have become accustomed to present equations in biochemistry. The views of readers on the desirability of these proposals are being sought.

Development of the enzyme list

Changes in the format: In the future, it is intended that references will be cited at the end of each entry with full title and pagination. In the past, the earliest available reference to a specific enzyme has usually been cited. It is hoped in the future, and starting with new additions to the list, to give more complete and up-to-date references. Good reviews on the properties of any specific enzyme would be particularly valuable citations.

We intend to expand the Comments section for individual enzymes to include information on metabolic significance, relation to other listed enzymes, possible isoenzymes, codification of enzymes of specific interest to clinical chemists, sequence database information, etc. Suggestions for material to include for individual enzymes are always welcome.

Work for the provision of enzyme nomenclature in database format is in progress.

Links with other relevant databases: Several other nomenclature systems and databases are in existence. These include the World Health Organization (WHO) list of International Nonproprietary Names (INNs), the QU number system of the Committee on Nomenclature, Properties and Units (C-NPU) for classifying enzymes of relevance to clinical chemistry, the ReBase of restriction enzymes, etc.

The Enzyme nomenclature database must link to these and the most appropriate ways of doing this are under discussion. Comments and suggestions are welcome.

Deficiencies in the list of enzymes: Advice and suggestions concerning deficiencies or omissions are always welcome. Problems in the classification of monooxygenases, protein kinases/phosphatases, restriction enzymes and other nucleases, are obvious and it would be most helpful if expert groups could be formed to advise on how these might best be classified and unambiguously named.

Submission of new enzymes and corrections to existing enzymes: These can be made on forms available from Keith F. Tipton, Biochemistry Department, Trinity College, Dublin 2, Ireland. Fax: +353 1 677 2400. E-mail: ktipton@mail.tcd.ie

Submissions concerning peptidases should be sent to Alan J. Barrett, Peptidase Laboratory, Department of Immunology, Babraham Institute, Babraham, England

CB2 4AT. Fax: +44 1223 83 7952. E-mail: alan.barrett@bbsrc.ac.uk

Catalytic antibodies: Like enzyme nomenclature, it is proposed that the nomenclature of catalytic antibodies should be based on the reaction catalysed, rather than on structural features. As more than one different ‘abzyme’ catalysing the same general reaction may be produced, there is clearly a possibility for confusion. However, the catalytic behaviour and specificities may not be identical. Several possibilities are under discussion: they may be included in the Comments section for existing enzymes where they catalyse similar reactions, they might be given EC numbers of they might be given an ‘AB’ numbering system in a separate list based on the enzyme nomenclature classes. Comments on these possibilities and on the general value of such a listing would be most welcome.

Other catalytic molecules: As in the case of catalytic antibodies the listing of natural and artificial catalytic nucleotides and engineered enzymes with novel specificities could be of use. Advice and comments as to how this could be most helpfully effected are invited.

Other issues covered in the Newsletter include: Naming proteins; Terminology in immunology; Allergen nomenclature; Receptor nomenclature; and Current and future activities.

For further information on the 1996 Newsletter, contact: Prof. Claude Liébecq, Université de Liège, Quai Marcellis 14/011, B-4020 Liège 2, Belgium.

JCBN and NC-IUBMB on the World Wide Web

A Home Page on the World Wide Web has been established for the two committees. This can be found at: http://www.chem.qmw.ac.uk/iupac/jcbn

The Home Page explains the role of the committees and lists its publications, including a WWW full-text version of the recommendations on amino-acid and peptide nomenclature, on steroid nomenclature, on carbohydrate nomenclature and on enzyme nomenclature.

If you have any problems accessing this page, send an E-mail message to: g.p.moss@qmw.ac.uk