

Characterisation of finite length composites: Part IV—structural studies on injection moulded composites (Technical Report)

Synopsis: The microstructure of discontinuous fiber composites can be articulated by many parameters. In this collaborative study as part of series of parallel projects under the IUPAC Working Party IV.2.1 on Structure and Properties of Commercial Polymers, various laboratories have carried out measurements. Their results and observations are summarised in this paper. In this family of materials, the microstructure should be described by at least three parameters, namely fiber orientation distribution, fiber length distribution and fiber content.

It is shown in this work that there is a profound influ-

ence of the processing history on the microstructure for these composite materials, and that there is a considerable challenge in measuring the macro-, meso and microstructural aspects.

Introduction

The materials under investigation in this study are injection moulding engineering plastics which have been prepared by pultrusion compounding. It is now well established that this family of materials can produce significantly longer fibers in the moulded artefact than by traditional extrusion compounded means. This margin may reach as much as an order of magnitude higher aspect ratio, but depends upon the fiber/matrix system and the manner in which subsequent processing takes place. An optimum number average I/D ratio for extru-

sion compounded (short) fiber composites would be 100 to 200, but in the case of pultrusion compounded (long) fiber compounds) can reach values in excess of 1000; this very much depends on the processing geometry, flow path and mould cavity design, and actual magnitudes of attainable fibers lengths are always relative to the severity of processing. In some cases, individual residual fibers of the original length (l_0) have been observed in long fiber moulded parts. The conventional injection moulding process is used with effectively similar conditions for both feedstock variants; this forming process offering a limited range of processing variables for altering the microstructure-properties relationship.

Producing components composed of longer fiber reinforced composites provides interesting new challenges for characterisation, and changes in fiber length and orientation are more pronounced. The influence of the flow path and shear history has a profound effect upon the resultant microstructure and hence the ultimate properties. The rheological characterisation of these materials with an insight into the flow induced morphological changes is described elsewhere.

In moulded panel components, the extent of in-plane anisotropy arising from the injection moulding process can be moderated by the methods reported by Allan and Bevis. In their novel process development, once the melt is injected into the mould in the normal way, it is pulsed in order to align polymer chains and fibers by shearing the fluid material remaining in the mould cavity by actuating pistons, typically these operate in the direction of mould-fill. Their process is known as the multiple live-feed process.

The microstructure of injection mouldings is extremely complex. It is challenging to attempt to characterise the fiber and molecular orientation of both conventional and multiple live-feed injection moulded samples. It is often convenient to visualise the microstructures attained by the simple model of through thickness skin/core/skin layers, and for this study it was our intention to produce some variations by influencing the flow and hence the processing conditions which dictate the resultant 'structure'. If a wide range of moulding conditions are used, and the resultant moulded parts are truly 'structures' then there is an implication that each structure requires experimental characterisation of its morphology before any description of the overall mechanical properties and the material properties is possible.

In order to gain this understanding, a move towards a quantitative microstructural characterisation is necessary. This paper is part of a series from the work carried out by IUPAC Working Party IV.2.1 and focuses on the microstructural issues observed by the contributors. In principle, this involves a measurement of fiber length distribution, fiber content and the fiber orientation func-

tion.

In exploring the relationship property-structure-processing and rheology we intend to conduct the work with both traditional and multiple live-feed mouldings. Moreover, the materials will have two different fiber systems (glass and carbon, Kevlar® is omitted) and two different matrix materials (polyamide 6,6 and polypropylene). This paper forms part of a series concerned with these materials which describes the mechanical properties, processing routes and flow characteristics of this family of materials. Moreover, the microstructural data in this study is used to model the stiffness in Paper V which follows on in this series of papers.

The following laboratories have contributed to this project under the umbrella of an 'AC working party (Working Party IV.2.1) and this hopefully adds value to the contribution of this work:

- Laboratory 1 ICI Materials (D.R. Moore, R.S. Bailey, G. v Bradsky, R.S. Prediger). Laboratory 2 Shell Research Arnherm, (A. Cervenka).
- Laboratory 3 Rhone-Poulenc, (Y. Giraud).
- Laboratory 4 Huls AG, (H. Motz).
- Laboratory 5 National Research Council Canada, (T. Vu-Khanli).
- Laboratory 6 Brunel University, (M.J. Bevis, P.S. Allan).
- Laboratory 7 BP Chemicals, (M.J. Cawood, A. Gray, with contributions from the A. Duckett at the IRC, Leeds University).
- Laboratory 8 Institut für Technische und Makromolekulare Chemie, Hamburg (H.G. Zachmann, G. v Krosigk).

This report was prepared for publication by: G.J. von Bradsky, R.S. Bailey¹, A.J. Cervenka, H.G. Zachmann and P.S. Allan ('ICI Technology, PO Box 90, Wilton, Middlesbrough, Cleveland TS90 8JE, UK), for the Working Party on Structure and Properties of Commercial Polymers, of the Commission on Polymer Characterisation and Properties, Macromolecular Division. The full details are to be found in Pure Appl. Chem. 1997, 69, 2523–2539.

Characterisation of finite length composites: Part VI—Rheological studies of materials based on the polypropylene matrix (Technical Report)

Synopsis: A range of rheological and morphological techniques, contributed by nine laboratories, are used to characterise the flow behaviour in a model long fiber reinforced thermoplastic system. It is concluded that in capillary rheometry, the pressure drop fluctuations that typify the flow arise from two mechanisms, that of local fiber fraction inhomogeneity passing through the die,

and the instability of the vortices in the die entry region which worsen as shear rate is increased. It is clear that the test geometry is significant in both capillary and torsional measurements. Yield stresses of 3.5 Pa (5 mm fiber length) and 7 Pa (10 mm fibres) have been evaluated.

Introduction

The materials under study are commercially available as pultrusion compounded injection moulding compounds and are known as long fiber reinforced thermoplastics. These materials offer an increased precursor fiber length over their conventional extrusion compounded counterparts. The granular feedstock for these materials is highly anisotropic with bundles of fibres aligned along the granule axis. After flow through nozzle, runner and gates in an injection moulding machine, the fibres become more uniformly dispersed in the mould cavity. The fibres are oriented more randomly in the moulded part, to the extent that controlled pyrolysis of the matrix polymer in a component may leave the shape retained by the residual fiber skeleton intact. The rheology in the mould cavity, therefore, differs from that of the feedstock. Some aspects of the rheology of this class of mouldable thermoplastic fiber composite have been reported by Gibson, and Gibson, Corscadden & McClelland using an instrumented moulding machine nozzle; fiber bundles are still observed in polymer taken from the nozzle region in spite of the preshearing history. It is now a requirement for materials selection that an understanding of both high shear rate and in-cavity rheology is established for design practices. This places a requirement for at least a reproducible flow curve to be available, which can be fitted by a simple curve fit for injection mould filling simulation software.

Converging flow in the entry into a die or gate is expected to be particularly important with high Trouton ratios of about 100 reported for a long fiber moulding compound by Gibson, and Gibson & Williamson. For long glass fiber in a nylon matrix Gibson has shown that the entry pressure drop through a moulding machine nozzle has a minimum at less than an included angle of 40°. This appears to be most pronounced at high flow rates, with the pressure drop almost independent of entry angle at lower flow rates. Corscadden has reported an increase in entry pressure drop with entry angle between 60° and 140° for long glass fiber in polypropylene using a ram extruder, with a maximum at about 120°, and with a minimum at less than 40° using an injection moulding rheometer at 5000 s⁻¹ shear rate. Some effect of the die diameter has been found with dough moulding compound (DMC) materials, but the effect of convergence ratio from the feed barrel diameter is unknown. All reported data are in a mixed shear and stretching

flow regime at high shear rates. These observations relate to an imposed die taper entry configuration and this may differ from the natural die entry angle which the material follows in a 180° entry angle.

The extreme anisotropy of the feedstock provides the opportunity to measure along the fiber and transverse components in a defined geometry of flow such as a parallel plate rotational rheometer. With both steady shear and dynamic modes available, this provides a more fundamental characterisation and may allow rules for combining various sources of data for this type of material to be explored.

Since these compounds are used exclusively for injection moulding of engineering components, the type of flow which is characterised in this study is likely to be afflicted with pressure fluctuations and granule memory effects on a level which will not be as dramatic in commercial operations when the material will be plasticised on melting.

In commercial applications, materials are employed with a fiber loading (in weight %) from 30 to 60%. The fiber characteristics always dominate the mechanical properties. The influence of processing techniques and microstructure on the mechanical properties are addressed in the parallel study of this working party. The microstructural characterisation of these materials has been addressed for this family of materials for fiber length, orientation and dispersion by previous workers, however there has been little investigation into the passage of these materials through convergent flow.

Fiber length attrition is reported to be brought about predominantly by the screw preplasticisation in the injection moulding machine. Secondary attrition processes do occur at high shear rates which are of less significance.

Fiber orientation and dispersion play a far greater role in the flow characterisation. There is no clear picture of the mechanisms of how these fiber composites pass through flow constrictions with minimal fiber attrition which is evident from the dramatic melt fracture which occurs on elastic recovery of the fibres during die exit.

The determination of fiber orientation for these has been approached by a number of workers using image analysis and image processing from polished sections taken through moulded components and flow channels. In a section through the composite, intersected fibres appear as ellipses which are light against a darker matrix background. These fields of view are converted into binary images by image processing. The orientation of the fibres can be determined from the angle of the major and minor axis of the ellipse relative to fixed reference axes in three dimensional space. It is customary to set the predominant flow direction as the X-axis in simple geometries. In mould filling studies, in a rigid fiber system, the fibres tend to be aligned by shear forces on

entering a die and misaligned (relative to the flow direction) upon divergence. This gives rise to the classical 'fountain flow' mechanism, associated with the advancing flow front in mould cavities.

The active participants in this collaboration are identified in the text as follows:

Laboratory

1. BASF Aktiengesellschaft, LudwigsWen, Germany.
2. Solvay Central Lab., Bruxelles, Belgium.
3. ICI Materials, Wilton, UK.
4. Shell Chemical Research Centre, Louvain-la-Neuve, Belgium.
5. DuPont de Nemours & Co., Engineering Technical Lab, Wilmington, USA.
6. Hoechst Celanese, Summit, USA.
7. Technical University of Denmark, Lyngby, Denmark.
8. National Research Council Canada, Quebec, Canada.
9. Hoechst AG, Kunststoff-Forschung, Frankfurt, Germany.
10. University of Karlsruhe, Germany.

This report was prepared for publication by: R.S. Bailey¹ and D.J. Groves (ICI Technology, PO Box 90, Wilton, Middlesbrough, Cleveland TS90 8JE, UK), for the Working Party on Structure and Properties of Commercial Polymers, of the Commission on Polymer Characterisation and Properties, Macromolecular Division. The full details are to be found in Pure Appl. Chem. 1997, 69, 2541–2565.

Studies on biodegradable poly(hexano-6-lactone) fibers 1. Structure and properties of drawn poly(hexano-6-lactone) fibers (Technical Report)

Synopsis: Using high molecular weight ($M_n = 80\,000$) Poly(hexano-6-lactone) (PCL*), tough and high tenacity PCL monofilaments with various draw ratios (undrawn to 9 times drawn) were prepared by melt-spinning. The relationship between microstructure and properties of the PCL fibers is described in this current IUPAC Technical Report. Analysis of microstructure of the drawn PCL fibers by wide-angle X-ray diffraction revealed typical c-axis orientation with an increase in crystallinity. It was also supported by sonic velocity measurements. The thermal, mechanical, and dynamic mechanical properties of the PCL fibers were affected significantly by draw ratio. DSC thermograms showed that the melting temperature and the enthalpy of fusion increased with draw ratio. The temperature dependence curves of

The name 'ε-caprolactone' is commonly used rather than the IUPAC nomenclature 'hexano-6-lactone'; hence the abbreviation PCL, based on the former, is used throughout this Technical Report.

dynamic viscoelasticity showed that the temperature at $\tan \delta$ peak of α dispersion corresponding to the glass transition temperature shifted toward higher temperature and the peak value of $\tan \delta$ decreased with draw ratio. The dynamic storage modulus and the sonic modulus increased with draw ratio. These results are due to the increase in crystallinity and molecular orientation with drawing, and are responsible for an increase in tensile tenacity as well as knot tenacity of the PCL fibers.

This report was prepared for publication by: Masatsugu Mochizuki¹, Kazuo Nakayama², Renyuan Qian³, Bing-Zheng Jiang⁴, Matsuo Hiram¹, Toshio Hayash⁵, Toshiro Masuda⁶ and Akio Nakarnia⁷ (¹Research and Development Center, Unitika Ltd., 23, Uji-Kozakura, Uji, Kyoto 611, Japan; ²National Institute of Materials and Chemical Research, Tsukuba, Ibaraki 305, Japan; ³Institute of Chemistry, Academia Sinica, Beijing 100080, China; ⁴Changchun Institute of Applied Chemistry, Academia Sinica, Changchun, Jilin, China; ⁵Research Institute for Advanced Science and Technology, Osaka Prefecture University, Sakai, Osaka 593, Japan; ⁶Department of Material Chemistry, Kyoto University, Yoshida, Sakyou-ku, Kyoto 606-01, Japan; ⁷4-1-5 Midoridai, Kawanishi, Hyogo 666-01, Japan) for the Working Party on Structure and Properties of Commercial Polymers, of the Commission on Polymer Characterisation and Properties, Macromolecular Division. The full details are to be found in Pure Appl. Chem. 1997, 69, 2567–2575.

Properties and units in the clinical laboratory sciences: Part III. Elements (of properties) and their code values (Technical Report) (IUPAC–IFCC 1997)

Synopsis: We have prepared a coding scheme for the elements (concepts) in the subject field 'clinical laboratory sciences'. The scheme uses code values taken from international coding schemes that provide code values for the elements in the various subspecialties which are represented in the subject field. The coding scheme for elements is accessible on Internet from the C-NPU Home page address: http://inet.uni-c.dk/home/ifcc_iupac_enpu

Preface

The present document is the third part of a series on properties observed in the clinical laboratory sciences initiated in 1987.

The series will comprise the five general parts (I–IV and XI) and a series of special parts:

- I Syntax and semantic rules

- II Kinds-of-property
- III Elements (of properties) and their code values
- IV Properties and their code values
- V Properties and units in Thrombosis and Haemostasis
- VI Properties and units in IOC prohibited Drugs
- VII Properties and units in Inborn Errors of Metabolism
- VIII Properties and units in Clinical Bacteriology
- IX Properties and units in Trace elements
- X Properties and units in General Clinical Chemistry
- XI Coding systems—structure and guidelines
- XII Properties and units in Clinical Pharmacology and Toxicology
- XIII Properties and units in Reproduction and Fertility
- XV WWW databases
- XVI Properties and units in Clinical Allergology

The size and complexity of part III, IV and XV is such that they will be presented in electronic format. The overall aim is access by electronic media of: 'Compendium of terminology and nomenclature of properties in clinical laboratory sciences'. 'Glossary of terms in quantities and units in clinical chemistry'. 'Properties and units in the clinical laboratory sciences'.

Definitions

code value: result of Applying a coding scheme to an element in a coded set.

coding scheme: collection of rules that maps the elements of one set on to the elements of a second set.

international coding scheme identifier, ISCI: identifier assigned to uniquely identify a registered coding scheme for use in information interchange.

Subject field: section of human knowledge, the borders of which are defined from a purpose-related point of view.

NOTE—In terminology science and its practical applications, the subject field is determined through the establishment of systems of concepts.

Term list: collection of terms to be subjected to further terminology work.

Introduction

Authoritative coding schemes in the health care domain are much needed for the electronic exchange of information on assays across language and cultural barriers.

In the clinical laboratory sciences there is a tradition for systematic expression of laboratory examination and the number of examinations performed is considerable, that is 5 to 10 per inhabitant per year.

To facilitate data exchange, a coding scheme for terms indicating properties has been prepared (part IV of this series). The elements (words, concepts, building blocks) of these terms for properties are listed as a term

list in the present document in the form of a coding scheme comprising:

1. An international coding scheme identifier, and a code value representing a concept.
2. The linguistic expression of the concept in English and in some other language.

The listings are given both in code value order and in alphabetic order. The size of the listings is considerable, and they are therefore accessible on Internet only. This also facilitates updating.

*This report was prepared for publication by: I. Bruunshuus¹, Wilhelm Frederiksen², H. Olesen¹ and I. Ibsen¹ (¹Dept. of Clinical Pharmacology Q 76.4.2, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark; ²Dept. of Clinical Microbiology, Statens Serum Institute, Copenhagen, Denmark. Please forward comments to: H. Olesen, Dept. Clin. Pharmacol. Q 76.4.2, Copenhagen University Hospital (Rigshospitalet), 20 Tagensvej, DK-2200 Copenhagen, Denmark. Fax: +45 35 45 27 45; email: qukb7642@inet.uni-c.dk or iibsen@rh.dk), for the Commission on Nomenclature, Properties and Units (C-NPU), Clinical Chemistry Section, Chemistry and Human Health Division (Technical Report), and the Committee of Nomenclature, Properties and Units (C-NPU), Scientific Division, from the International Federation of Clinical Chemistry (Recommendation 1997). The full details are to be found in Pure Appl. Chem. 1997, **69**, 2577–2582.*

Properties and units in the clinical laboratory sciences: Part IV. Properties and their code values (Technical Report) (IUPAC–IFCC 1997)

Synopsis: To facilitate and to assure correct electronic transmission of request and report on clinical laboratory properties over cultural and linguistic barriers, a systematic nomenclature has been prepared for a series of laboratory specialities.

Each defined property has been given a unique code value preceded by the coding scheme identifier: NPU.

The NPU code value and its adhering code value string for each term allow expression of the concept according to local script, idiom or conventions.

The coding scheme is accessible on Internet from C-NPU Home page address http://inet.uni-c.dk/home/ifcc_iupac_cnpu.

Scope

The coding scheme prepared is intended as a repository of code values and terms of properties to be used in the transfer of information on such properties through

computing and telecommunication equipment used in the health services.

Preface

The document is the fourth part of a series on properties measured in the clinical laboratory sciences initiated in 1987.

The series will comprise the five general parts (I–IV and XI) and a series of special parts:

- I Syntax and semantic rules
- II Kinds-of-property
- III Elements (of properties) and their code values
- IV Properties and their code values
- V Properties and units in Thrombosis and Haemostasis
- VI Properties and units in IOC prohibited Drugs
- VII Properties and units in Inborn Errors of Metabolism
- VIII Properties and units in Clinical Bacteriology
- IX Properties and units in Trace elements
- X Properties and units in General Clinical Chemistry
- XI Coding systems—Structure and guidelines
- XII Properties and units in Clinical Pharmacology and Toxicology
- XIII Properties and units in Reproduction and Fertility
- XV WWW databases
- XVI Properties and units in Clinical Allergology

The size and complexity of part III and IV is such that their lists will be presented in electronic format only.

The overall aim is access by electronic media of:

'Compendium of terminology and nomenclature of properties in clinical laboratory sciences'

'Glossary of terms in quantities and units in clinical chemistry'

'Properties and units in the clinical laboratory sciences' (the present series of documents).

Introduction

The variety of properties observed in the domain of the Clinical Laboratory Sciences is well over 5000. The number of properties observed is 5 to 10 per inhabitant per year in industrialised countries.

An increasing part of the billions of requests and reports is transmitted by electronic means, mostly by code values from a local coding scheme.

The expression of the meaning of a code value is according to local habit, rules and conventions. This often is not readily transformed to coded sets from other coding schemes.

To facilitate inter region electronic communication, the European standard ENV 1614:1995 has presented a system of concepts based on for a systematic nomenclature to function as a bridge between local dialects.

Based on this system of concepts and on the European standard ENV 12435:1996, that deals with the presentation of results, terms have been elaborated and

codified for communication between clinical laboratory information systems and other health information systems.

A basic document for further description and clarification is 'Compendium of terminology and nomenclature of properties in the clinical laboratory sciences', while details of the syntax and semantic rules are given in.

*This report was prepared for publication by: H. Olesen¹, D. Kenny², I. Bruunshuus¹, I. Ibsen¹, K. Jorgensen³, R. Dybkaer⁴, X. Fuentes-Arderiu⁵, G. Hill⁶, P. Soares De Araujo⁷ and C. McDonald⁸ (¹Dept. of Clinical Pharmacology Q 76.4.2, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark; ²Dept. of Clinical Biochemistry, Our Lady's Hospital for Sick Children, Dublin 12, Ireland; ³Retired. Formerly Dept. of Clinical Biochemistry KB 3.01.1, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark; ⁴Dept. of Standardisation in Laboratory Medicine, Kommunehospitalet Copenhagen, Denmark; ⁵Dept. of Clinical Biochemistry, Ciutat Sanitària i Universitària de Bellvitge, Barcelona, Spain; ⁶Dept. of Clinical Chemistry, Hospital for Sick Children, Toronto, Canada; ⁷Dept. of Biochemistry, IQUSP, São Paulo, Brazil; ⁸Regenstrief Inst. for Health Care, Indiana University School of Med., Indianapolis, Indiana, USA. Please forward comments to: H. Olesen, Dept. Clin. Pharmacol. Q 76.4.2, Copenhagen University Hospital (Rigshospitalet), 20 Tagensvej, DK-2200 Copenhagen, Denmark. Fax: +45 35 45 27 45; e-mail: qukb7642@inet.uni-c.dk or iibsen@rh.dk.) for the Commission on Nomenclature, Properties and Units (C-NPU), Clinical Chemistry Section of the Chemistry and Human Health Division, (Technical Report 1997), and the Committee of Nomenclature, Properties and Units (C-NPU), Scientific Division, from the International Federation of Clinical Chemistry (Recommendation 1997). The full details are to be found in Pure Appl. Chem. 1997, **69**, 2583–2591.*

Properties and units in the clinical laboratory sciences: Part IX. Properties and units in trace elements (Technical Report) (IUPAC–IFCC 1997)

Synopsis: This document is the first Technical report-recommendation on the presentation of trace elements and their values in clinical laboratory sciences from International Federation of Clinical Chemistry and International Union of Pure and Applied Chemistry. It forms part of the ongoing effort to standardise requests and reporting of laboratory data for transmission across cultural and linguistic domains, without attempting to standardise the routine language used by clinicians and laboratory practitioners.

Other documents deal with syntax, kinds-of-property,

and properties and units used in other areas of clinical laboratory sciences.

The document is accessible on Internet from C-NPU Home page address: http://inet.uni-c.dk/home/ifcc_iupac_cnpu/

Preface

This document is the result of cooperation between the Commission on Toxicology of the International Union of Pure and Applied Chemistry (IUPAC) and the Committee/Commission on Nomenclature, Properties and Units of the International Federation of Clinical Chemistry (IFCC) and IUPAC.

The document is the ninth part (IX) of a series on properties examined in the clinical laboratory sciences, initiated in 1987.

The series will comprise:

- I Syntax and semantic rules
- II Kinds-of-property
- III Elements (of properties) and their code values
- IV Properties and their code values
- V Properties and units in Thrombosis and Haemostasis
- VI Properties and units in IOC prohibited Drugs
- VII Properties and units in Inborn Errors of Metabolism
- VIII Properties and units in Clinical Bacteriology
- IX Properties and units in Trace elements
- X Properties and units in General Clinical Chemistry
- XI Coding systems—structure and guidelines
- XII Properties and units in Clinical Pharmacology and Toxicology
- XIII Properties and units in Reproduction and Fertility
- XV WWW databases
- XVI Properties and units in Clinical Allergology

Foreword and scope

Basic research in biology and medicine and innovations in laboratory methodology have greatly increased the range of properties available to medical practitioners to help them in decisions on diagnosis, treatment and prevention of disease.

The plethora is now such that the individual physician has insight in or understanding of only a limited number of properties offered to him from the various clinical laboratory specialities.

In the laboratory, local terms (jargon) may be well understood among colleagues, but they are not appropriate for communication with the outside world. Likewise, a laboratory and its local community of users, such as hospital or community physicians, may use a 'local dialect' of the language of clinical laboratory sciences which is well understood by all concerned, but when the communication possibilities are wider, even transnational, risks of serious misunderstanding arise.

In addition, the terminology used by one laboratory

speciality may vary even within the speciality, and may be incomprehensible to another speciality. This is a minor inconvenience to the laboratory specialities, each one essentially operating within its own area of activity. However, for the user this is highly unsatisfactory and also may hinder treatment of the patient.

It is therefore essential to promote clear, unambiguous, meaningful and fully informative communication. Also, coherence of statements made within and between medical specialities, and uniformity in structure of presentation are to be striven for. This will facilitate transfer of information across cultural, alphabetic and language areas.

The purpose of this document is to Apply the IUPAC–IFCC recommended syntax structures for request and report, providing formats and terms of properties examined in the domain of Trace Elements, in order to facilitate unequivocal written or electronic communication between health care professionals.

The list of properties shown in this document is not exhaustive; it is a collection of realistic examples.

*This report was prepared for publication by: R. Cornelis¹, X. Fuentes-Arderju², I. Bruunshuus³ and D. Templeton⁴ (¹Laboratory of Analytical Chemistry, Institute for Nuclear Sciences, Universiteit Gent, Gent, Belgium; ²Department of Clinical Biochemistry, Ciutat Sanitària i Universitària de Bellvitge, L'hospitalet de Llobregat, Barcelona, Spain; ³Department of Clinical Pharmacology Q 7642, National University Hospital (Rigshospitalet), Copenhagen, Denmark; ⁴Department of Clinical Biochemistry, Banting Institute, Faculty of Medicine, University of Toronto, Canada; Please forward comments to: R. Cornelis, Laboratory for Analytical Chemistry, Instituut Nucleaire Wetenschappen, Universiteit Gent, Proeftuinstraat 86, B-9000 Gent, Belgium. Fax: +32 9 264 66 99; email: rita.cornelis@rug.ac.be), for the Commission on Nomenclature, Properties and Units (C-NPU), Commission on Toxicology (C-TOX) of the Clinical Chemistry Division (Technical Report 1997), and the Committee of Nomenclature, Properties and Units (C-NPU), Scientific Division, from the International Federation of Clinical Chemistry (Recommendation 1997). The full details are to be found in Pure Appl. Chem. 1997, **69**, 2593–2606.*

Properties and units in the clinical laboratory sciences: Part XI. Coding systems—structure and guidelines (Technical Report) (IUPAC–IFCC 1997)

Synopsis: In ENV1614:1995 the system of concepts for properties in the clinical laboratory sciences has been elaborated and in part 1 of this series the syntax and semantic rules are presented.

The present document deals with the procedures for assembling the elements of a term for a property into a string of code values representing the intensional definition of a property. This is done by use of semantic links that ensure the correct localisation of the elements according to the syntax rules.

Further some special features needed as extensions to the general structure are presented.

Preface

The present document is the eleventh part (XI) of a series on properties examined in the clinical laboratory sciences, initiated in 1987.

The series will comprise the five general parts (I–IV and XI) and a series of special parts (in various stages of appearance in various media):

- I Syntax and semantic rules
- II Kinds-of-property
- III Elements (of properties) and their code values
- IV Properties and their code values
- V Properties and units in Thrombosis and Haemostasis
- VI Properties and units in IOC prohibited drugs
- VII Properties and units in Inborn Errors of Metabolism
- VIII Properties and units in Clinical Bacteriology
- IX Properties and units in Trace Elements
- X Properties and units in General Clinical Chemistry
- XI Coding systems—structure and guidelines (*this document*)
- XII Properties and units in Clinical Pharmacology and Toxicology
- XIII Properties and units in Reproduction and Fertility
- XV WWW databases
- XVI Properties and units in Clinical Allergology

The size and complexity of part III, IV and XV are such that their lists will be presented in electronic format only. The overall aim is access by electronic media of: 'Compendium of terminology and nomenclature of properties in clinical laboratory sciences'. 'Glossary of terms in quantities and units in clinical chemistry'. 'Properties and units in the clinical laboratory sciences'.

Foreword and scope

The hardware and software facilities for electronic storage, transfer and handling of data are such that multi-purpose databases can be made accessible at low cost without geographic restriction. The versatile and flexible underlying structures allow for ease of access and retrieval of data and gives presentation formats fully comparable to printed counterparts. Because of ease of use and because of the wider distribution of the information, misinterpretation is more likely to occur than in oral or written presentation for more restricted and culturally more homogeneous audiences. This necessitates some harmonisation/standardisation of data on trans-

fer, while allowing local expression forms at sender and receiver ends. This in particular applies when specific concepts are to be expressed in different languages and different scripts.

This document is part of an ongoing international effort to agree on some sort of 'standardisation' of the transmission of 'laboratory results'. It centres on the description of two coding schemes developed for that purpose and gives guidelines and rules for their use.

The two coding schemes pertain to:

1. Coding scheme 1: code values for elements (of properties)
2. Coding scheme 2: code values for properties and their units

Introduction

In the clinical laboratory sciences, much effort has been given to the presentation of the outcome of analytical efforts. Thus a report from a laboratory may be presented as an equation:

$$\text{Property} = \text{Result}$$

The general rules for the left side of this equation are given in ENV1614:1995 and for the right side in ENV12435:1996.

Further details on formats for request and report are dealt with in the documents on syntax and semantic rules, and kinds-of-property and an extensive survey is in 'Compendium of terminology and nomenclature of properties in clinical laboratory sciences'.

These recommendations, standards and conventions as listed have been followed systematically in the coding schemes developed.

Although the formats apply to the majority of properties examined, some extensions and special features are needed in the daily routine application.

In the following a description of the coding schemes for properties and their elements are presented, with emphasis on special features, as are some guidelines for their use.

This report was prepared for publication by: H. Olesen¹, D. Kenny², R. Dybkær³, I. Ibsen¹, I. Bruunshuus¹, X. Fuentes-Arderiu⁴, G. Hill⁵, P. Soares De Araujo⁶ and C. McDonald⁷ (¹Dept. of Clinical Pharmacology Q 76.4.2, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark; ²Dept. of Clinical Biochemistry, Our Lady's Hospital for Sick Children, Dublin 12, Ireland; ³Dept. of Standardisation in Laboratory Medicine, Kommunehospitalet Copenhagen, Denmark; ⁴Dept. of Clinical Biochemistry, Ciutat Sanitària i Universitaria de Bellvitge, Barcelona, Spain; ⁵Dept. of Clinical Chemistry, Hospital for Sick Children, Toronto, Canada; ⁶Dept. of Biochemistry, IQUSP, São Paulo, Brazil; ⁷Regenstein Inst. for Health Care, Indiana University School of Med.,

Indianapolis, Indiana, USA. Please forward comments to: H. Olesen, Dept. Clin. Pharmacol. Q 76.4.2, Copenhagen University Hospital (Rigshospitalet), 20 Tagensvej, DK-2200 Copenhagen, Denmark. Fax: +45 35 45 27 45; email: ifcc-iupac-cnpu@inet.uni-e.dk or iibsen@rh.dk), for the Commission on Nomenclature, Properties and Units (C-NPU), Clinical Chemistry Section, of the Chemistry and Human Health Division (Technical Report 1997), and the Committee of Nomenclature, Properties and Units (C-NPU), Scientific Division, from the International Federation of Clinical Chemistry (Recommendation 1997). The full details are to be found in *Pure Appl. Chem.* 1997, **69**, 2607–2620.

Properties and units in the clinical laboratory sciences: Part XIII. Properties and units in reproduction and fertility (Technical Report) (IUPAC–IFCC 1997)

Synopsis: This document is the first technical report—recommendation on the presentation of properties in reproduction and fertility and their values in clinical laboratory sciences from The International Society of Andrology, International Federation of Clinical Chemistry and International Union of Pure and Applied Chemistry. It forms part of the ongoing effort to standardise requests and reporting of laboratory data for transmission across cultural and linguistic domains, without attempting to standardise the routine language used by clinicians and laboratory practitioners.

The document is accessible on Internet from C-NPU Home page address: http://inet.uni-c.dk/home/ifcc_iupac_cnpu

Preface

This document is the result of cooperation between the International Society of Andrology and the Committee/Commission on Nomenclature, Properties and Units of the International Federation of Clinical Chemistry (IFCC) and the International Union of Pure and Applied Chemistry (IUPAC).

The present document is the thirteenth part (XIII) of a series on properties observed in the clinical laboratory sciences, initiated in 1987.

The series will comprise the five general parts (I–IV and XI) and a series of special parts:

- I Syntax and semantic rules
- II Kinds-of-property
- III Elements (of properties) and their code values
- IV Properties and their code values
- V Properties and units in Thrombosis and Haemostasis
- VI Properties and units in IOC prohibited Drugs
- VII Properties and units in Inborn Errors of Metabolism

- VIII Properties and units in Clinical Bacteriology
- IX Properties and units in Trace Elements
- X Properties and units in General Clinical Chemistry
- XI Coding systems—structure and guidelines
- XII Properties and units in Clinical Pharmacology and Toxicology
- XIII Properties and units in Reproduction and Fertility
- XV WWW databases
- XVI Properties and units in Clinical Allergology

Foreword and scope

Basic research in biology and medicine and innovations in laboratory methodology have greatly increased the range of properties available to medical practitioners to help them in decisions on diagnosis, treatment and prevention of disease.

The plethora is now such that the individual doctor has insight in or understanding of only a limited number of properties offered to him from the various clinical laboratory specialities.

In the laboratory, local terms (jargon) may be well understood among colleagues, but they are not appropriate for communication with the outside world. Likewise, a laboratory and its local community of users, such as hospital or community physicians, may use a 'local dialect' of the language of clinical laboratory sciences which is well understood by all concerned, but when the communication possibilities are wider, even transnational, risks of serious misunderstanding arise.

In addition, the terminology used by one laboratory speciality may vary even within the speciality, and may be incomprehensible to another speciality. This is a minor inconvenience to the laboratory specialities, each one essentially operating within its own area of activity. However, for the user this is highly unsatisfactory and also it may hinder treatment of the patient.

It is therefore essential to promote clear, unambiguous, meaningful and fully informative communication. Also coherence of statements made within and between medical specialities, and uniformity in structure of presentation is to be strived for. This will facilitate transfer of information over cultural, alphabetic and language areas.

The purpose of this document is to apply the IUPAC–IFCC recommended syntax structures for request and report, providing formats and names of properties observed in the domain of Reproduction and Fertility, in order to facilitate unequivocal written or electronic communication between health care professionals.

The list of properties shown in this document is not exhaustive.

The main background document is the WHO laboratory manual for the examination of human semen and sperm-cervical mucus interaction.

This report was prepared for publication by: H. Olesen¹, A. Giwercman², D. M. de Kretser³, D. Mortimer⁴, H. Oshima⁵ and P. Troen⁶ (¹Department of Clinical Pharmacology Q 7642, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark ²Department of Growth and Reproduction JMC 5064, Copenhagen University Hospital (Rigshospitalet), Copenhagen, Denmark; ³Institute of Reproduction and Development, Clayton, Victoria, Australia; ⁴Sydney Andrology, Sydney WF, Sydney, Australia; ⁵Department of Urology, Tokyo Medical and Dental University, Tokyo, Japan; ⁶University of Pittsburgh Medical Center, Pittsburgh, USA.

Please forward comments to: H. Olesen, Dept. Clin. Pharmacol. Q 76.4.2, Copenhagen University Hospital, Tagensvej 20, DK-2200 Copenhagen, Denmark), for the Commission on Nomenclature, Properties and Units (C-NPU), Clinical Chemistry Section, of the Chemistry and Human Health Division (Technical Report 1997), the International Society of Andrology (Recommendation 1997) and the Committee of Nomenclature, Properties and Units (C-NPU), Scientific Division, from the International Federation of Clinical Chemistry (Recommendation 1997). The full details are to be found in Pure Appl. Chem. 1997, **69**, 2621–2638.

News

Committee on Science and Technology in Developing Countries (COSTED)

The following are extracts from the minutes of the 25th COSTED Executive Committee meeting, Irbid-Amman, Jordan, 25–27 February 1997.

Chairman's opening remarks

The Chairman greeted the host country dignitaries and acknowledged the generous support by Yarmouk University in hosting the meetings and facilitating the preparations for the meeting. He recalled the warm opening remarks of Prof. Kamal and congratulated Dr Owais for the excellent arrangements. He placed on record deep appreciation for the services of the outgoing members of the Executive Committee, Prof. M.G.K. Menon, Prof. R.R. Daniel, Prof. R.D. Keynes, Dr D.A. Bekoe, Dr D. Ouazar, Dr I. Head, Dr H. Leutner, Dr D. Norse and Dr T. Freyvogel. He welcomed the attending new EXCOM members, Prof. M. Addy, Dr E.M. Krieger, Dr D.M. Polter, Dr Alain Ruellan. He noted that Prof. K. Gulamov, Dr Su Jilan, O. Kitani, Prof. C.N.R. Rao and Mr V. Zharov expressed regret at their inability to participate. The Chairman also thanked ICSU for continued support, co-operation and the opportunity provided for a COSTED presentation at the 25th ICSU General Assembly. The co-sponsorship and sustained support of UNESCO was gratefully acknowledged. The contribution and continuing support by the National Members of COSTED–IBN was also warmly acknowledged. The Chairman also underscored the challenging goals for COSTED—exemplified by the extraordinary range of themes on the agenda—and urged everyone to combine vision and pragmatism in the work.

Scientific secretary's report

A substantive report was made by the Scientific Secretary consisting of two parts, (i) a formal report on the activities of the Central Secretariat during 1996 and (ii) proposals on future need based activities in three broad areas, (a) Capacity Building in Science, (b) Technology Management and (c) Intellectual Property Rights. The report was very well received. The ensuing discussions endorsed the proposed activities as highly relevant. The committee recognised that technology management and IPR are highly important and relevant to the COSTED mandate. These areas have not been adequately addressed in developing countries nor have they been publicised at the national level. It was noted that COSTED–IBN has had a successful history of co-operation in basic sciences and it is timely to include technology aspects in its programmes. In view of the heterogeneous nature of developing countries, priorities in technology development and R&D need to be carefully identified as well as factors influencing co-operation in technology development. In summary, the committee was highly supportive of the new initiative to strengthen the T in COSTED as R&D in technology is perceived to contribute not merely to economic growth but to ensure sustainable economic growth. The Scientific Secretary proposed an activity for a capacity building programme in technology management in co-operation with the United States International University, San Deigo. The proposal was warmly received. It was recommended that the programme begin at the Asian level and be extended as rapidly as resources permit to other regions.

Agenda item 11.7—regional secretaries' reports

The following presentations were made on the regional COSTED-IBN activities.

COSTED Western and Central Africa	Dr Addy
COSTED Asia	Ravichandran for Thyagarajan
COSTED-IBN Latin America	Prof. Allende
COSTED-IBN Arab Region	Dr Owais
African Biosciences Networks	Dr Ba
COSTED-IBN Southern & Central Africa	Dr Mokhele
AONBS	Dr Tanticharoen

The committee congratulated the COSTED-IBN Latin American Region for presenting an excellent example in successful networking as well as external fund raising for the networks. In general, the committee recognised the increased vibrancy and outreach of COSTED-IBN activities and expressed optimistic views about the progress made so far. The reports also indicated the heterogeneity of the different regions of the developing countries, the distinct nature of successful activities in each region and their integral benefits to COSTED-IBN as a whole. Dr Allende stressed the need for COSTED-IBN to transcend ICSU and UNESCO and truly represent the science and technology activities as perceived by the regions. Dr Owais highlighted the need for sensitisation of policy makers in the Arab region to be of primary importance and urgency. Dr Ba in presenting the ABN report made a case for soliciting additional funds to ensure greater effectiveness and success of the ABN activities which have been recently curtailed due to paucity of funds. Dr. Tanticharoen offered to host short-term training courses and split PhD Sandwich courses (less than 12 months) at the NCGEB, Bangkok and invited COSTED-IBN to take advantage of the same.

The report of the Arab Regional Co-ordinating Committee Meeting held at Yarmouk University just prior to the ExCom meeting will be circulated in due course.

Following are highlights of the report of the Planning Session for COSTED in Africa presented by Dr Mokhele.

- Strengthen existing networks
- Themes selected for networks should address research from basic, applied and incorporate commercialisation of research results
- Communication infrastructure essential for networks to function
- COSTED-IBN should better exploit capacity found in the broader ICSU and *vice versa*
- A number of themes for networks were suggested (e.g. remote sensing, structural engineering analysis)
- COSTED must project what *competitive advantages* as an ICSU committee it has to offer
- COSTED's role in Science and Society

- Strengthen COSTED Regional secretariats. Plans for COSTED in Africa (1997-2000); wherever possible, specific goals will be set for each year and progress will be reported in terms of these benchmarks.

- 1 Expand Natural Products Research Co-operation in Africa (NAPRECA) in West Southern Africa
 - 3 countries in each region networked by the next EXCOM meeting
- 2 Expand Biological Nitrogen Fixation Network
- 3 Establish network of researchers in Remote Sensing in 3 years
- 4 Enhance activities of network on structural engineering analysis.
- 5 Expansion of COSTED National Membership: All current ICSU National Members in Africa should join COSTED by next EXCOM. A vigorous campaign should be mounted.
- 6 Increase in number of National Academies of Science (Mokhele/Hassan: TWAS General Conference in Rio, September 1997)
- 7 Co-ordination of the activities of COSTED-IBN Secretariats in Africa and between these and the Central COSTED office in Madras
- 8 Strengthen the capacity of the Secretariats to play effective co-ordinating and facilitating role

At the end of the reporting session considerable discussion of the role, mission and philosophy of COSTED-IBN followed. Members expressed wide ranging views which included the need for a panoramic view of the organisation not influenced by regional insights. Recognising the diversity of the regional situations it was recommended that in future the Central Secretariat's report needs to present a collage of a central coherent programme without imposing uniformity on the specific actions in the regions. Members recognised that the uniqueness of COSTED-IBN was based on the fact that COSTED-IBN's link to ICSU is well structured and so is the regional outreach of COSTED-IBN in the developing countries. This is a distinct advantage in ensuring the effective fulfilment of the objectives with which the organisation was set up. COSTED-IBN is free to concentrate on applied sciences as found appropriate since the ICSU Unions focus to a great extent on basic sciences. The EXCOM urged COSTED-IBN to strengthen co-operation with the ICSU Unions and Committees and enhance its visibility so as to attract a greater role as an advisory body to the ICSU family in matters relating to science and technology for development. COSTED-IBN was requested to help increase ICSU membership in Africa and recommend the representation of new and young scientists from the developing regions to ICSU. Members desired that a report from COSTED-IBN feature on the agenda of the TWAS General Committee meeting in September 1997 as is being done in the United Nations meeting of the Commission

for Sustainable Development, in New York.

The idea that COSTED-IBN should strive to function as a match maker between activities and funds was warmly received by institutions. It was recommended that COSTED-IBN adopt a two-pronged approach: by fostering networks to strengthen scientific activities and by fostering partnerships to strengthen technical and industrial collaboration in developing countries. The need for information on the centres of excellence to facilitate training of scientists between the regions was stressed. It was proposed that the regional secretariats prepare a diagram of their structures which could be integrated by the Central Secretariat to present an overall structure of the organisation.

ISCU Assessment Report *vis-à-vis* COSTED-IBN

A suggestive input from Mme Julia Marton-Lefevre was discussed extensively. Views ranged from, preference for non-governmental new members, potential role of COSTED-IBN and ICSU to play a high level advisory role in influencing governments for greater support for science and technology, appropriateness of a review mechanism for ICSU and 'sunset' provision for programmes. The following consensus emerged regarding the Assessment Report.

- 1 ICSU should, as a priority help build the capacity of groups of scientists in the developing countries to form national academics or societies which could become National Scientific Members of ICSU. COSTED-IBN should be given the mandate, funds and assistance to undertake this on behalf of ICSU.
- 2 COSTED-IBN should contact present National Scientific Members of ICSU in developing countries and assist them to fulfill their roles as Members of ICSU better.
- 3 COSTED-IBN should organise high level meetings of scientists and policy makers, making the case—for the role of science in the development process and organise appropriate follow-up actions to this.
- 4 The ICSU Secretariat should be expanded to include a development officer from ICSU to help fund raising and membership drive.
- 5 The COSTED-IBN Regional Secretaries should be encouraged to set up regional scientific networks and link these to the appropriate International Scientific Unions and Committees.

New regional networks

Biodiversity networks

It was generally agreed that Biodiversity Networks in developing countries are extremely important. However, recognising that there are major global efforts already afoot in this area, COSTED-IBN should strive to

- 1 gather data on existing efforts in biodiversity in various regions to unearth local capacities and bottlenecks
- 2 identify the priorities and needs as perceived by the regions
- 3 facilitate the plugging in/hooks on of regional initiatives in biodiversity to important programmes like DIVERSITAS.
- 4 promote exchange of ideas and policy options for the South

Energy networks

The Committee endorsed in principle the proposal for an energy network proposed by the Scientific Research Council of Jamaica. It was noted that this was essentially an information exchange network. Mme Marton-Lefevre brought to the attention of EXCOM that ICSU has been anxious in the past few years to attempt a meaningful initiative in this area and she encouraged COSTED-IBN to explore this possibility. The Chairman asked the Scientific Secretary to examine the feasibility of an energy network for developing countries. Such networks in special programmatic areas could eventually be either expanded or disbanded as found appropriate.

CSC—COSTED-IBN collaboration: Project CREN

The proposal was presented by the Scientific Secretary who pointed out that COSTED-IBN collaboration in this initiative is solicited in view of CREN expanding beyond the Commonwealth Countries. The EXCOM approved the proposal in principle and members offered a number of suggestions for co-operation. These ranged from working in partnership with other ICSU bodies in this area, IUPAC/CHEMRAWN, IUGS (waste disposal) China CAST (Cleaner production) ISSS (training). The Scientific Secretary was requested to pursue COSTED-IBN collaboration with CREN in the light of the above suggestions.

Brain storming session on general issues

1. Concept of networking in COSTED-IBN

Stimulating discussions led to the following broad ideas on the concept of networking in COSTED-IBN.

Definition of Network: Organised manner of linking scientists, technologists and scientific and technical institutions and bodies in a continuous manner for a common objective.

Advantages:

- provides scope for the birth of new networks
- acts as a tool for access to information at national, regional and international levels.

- facilitates exchange of experience, research methodology and formulation of joint strategies for common problems.
- provides directionality for efforts based on collective expertise
- facilitates pooling of resources
- facilitates grass root level participation and contribution
- presents a collective voice and therefore a better credibility in fund raising and effective implementation.

Disadvantages:

- local disparities may sometimes hinder networking
- success depends on the motivation, participation and response of the networking partners
- sustenance of the network depends on the correct identification of objectives and priorities and periodic review of the same

Action:

- Each regional secretariat to prepare a working draft on the regional experience in networking in all areas of science.
- The central secretariat to integrate the drafts and come up with a paper highlighting the successes and failures of the regional networks and the factors influencing them (e.g. political, financial, psychological, etc.)
- based on this study, the regional and central secretariats to formulate a strategy for a concerted action plan for regional networking in new areas under the COSTED umbrella.
- to address two important prerequisites for networking: (i) strengthening the secretariat through access to electronic communication, (ii) getting access to services and resources for dissemination.

2. The Mission of COSTED

It was unanimously felt that the objectives of COSTED-IBN as defined in the constitution are comprehensive and broad enough. The purpose of the brainstorming session was to arrive at a definition or action to operationalise these objectives. In this context, views expressed were strongly in favour of strengthening the linkages between S and T as well as between T and economic development. ICSU has upheld the voice for science all along. However, the ICSU assessment report considers applied areas of science and the development process to be of high priority in the future. Thus COSTED-IBN must take into account the emerging trends and priorities in global S&T. It was pointed out that COSTED-IBN will increasingly be called upon to play an advisory role on science for policy and policy for science and this should be amply reflected in the at-

tempt to define the goals. Based on the above discussions, a draft of COSTED's key objectives prepared by Dr Allende was revised as follows:

- 1 to strengthen, organise and integrate the scientific communities of the developing regions of the world.
- 2 to stimulate and facilitate the participation of the scientists and scientific institutions of the developing countries in the activities of international science and technology.
- 3 to generate programmes and projects that increase the scientific and technological capacity of developing countries to address problems relevant to their cultural and socio-economic development and or international scope.
- 4 to provide advice on science and technology policies to governments and other concerned Institutions in the developing world.

New books

COSTED has announced the availability of the following books.

Concepts in biotechnology. Editors: D. Balasubramanian, C.F.A. Bryce, K. Dharmalingam, J. Green & Kunthala Jayaraman. Published by Universities Press (India) Limited 3-5-820, Hyderguda, Hyderabad 500 029, A.P. India. Distributed by Orient Longman Limited. Contact the nearest Orient Longman Office or mail your order to Orient Longman Limited, 3-6-272 Himayatnagar, Hyderabad 500 029, A.P., Tel.: (040) 240294, 240305, 240306, 240391, fax: (040) 240393, E-mail: info@orienth.globemail.com ed.co@orientlongman.sprintpg.ems.vsnl.net.in

This textbook is the outcome of a COSTED-IBN project on curriculum development in biotechnology for undergraduate study, especially for students in developing countries. It is designed to provide a strong base in this emerging, interdisciplinary area which holds great promise for economic development.

The early chapters review the structure and function of biological molecules and living cells, and the way in which cellular structure and function is controlled by the genetic makeup of the cell. The diverse technologies associated with the application of living systems in select areas—such as health care, agriculture, animal systems, bioprocess technologies—are then described. Finally, the impact of biotechnology on the environment, and ethical and social implications of this technology are discussed.

- A model textbook in Biotechnology for undergraduate and postgraduate students.
- Covers the fundamental principles and concepts which form the basis for the subject.
- Illustrates their applications in select areas such as

health care, agriculture, animal systems, bioprocess technologies and the environment.

- Provides an insight into the impact of biotechnology on international competition, trade, societies in developing countries, their economy, way of life and social structure.
- Numerous assignments and self assessment exercises designed to reinforce key concepts.
- Every chapter has a Further Reading List.
- The glossary of technical terms further enhances the usefulness of the book

Contents

- 1 From Cell Biology to Biotechnology
 - 2 Interplay of Macromolecules in a Living Cell
 - 3 Structural and Functional Dynamics of the cell
 - 4 Gene Structure and Expression
 - 5 Gene Technology
 - 6 Protein Engineering and Design
 - 7 Enzyme Technology
 - 8 Bioprocess Technology: Exploitation of Microorganisms
 - 9 Bioprocess Technology: Exploitation of Animal Cells
 - 10 Immunotechnology
 - 11 Biotechnology as a New Frontier in Health
 - 12 Plant Biotechnology
 - 13 Animal Biotechnology
 - 14 Bioinformatics and Pattern Recognition in DNA and Protein Sequences
 - 15 Marine Biotechnology
 - 16 Impact of Biotechnology on the Stability of the Environment
 - 17 Biotechnology, international competition, and Economic, ethical and social implications in developing countries
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The Editors

Prof. D. Balasubramanian, Director, Centre for Cellular and Molecular Biology, Hyderabad, India.

Prof. C.F.A. Bryce, Dean, Faculty of Science, and Head, Department of Biological Sciences, Napier University, Edinburgh, Scotland.

Prof. K. Dharmalingawn, Head and Coordinator, School of Biotechnology, Madurai Kamaraj University, Madurai, India.

Dr J. Green, School of Biotechnology, Napier University, Edinburgh, Scotland.

Prof. Kunthale Jayaram, Head, Centre for Biotechnology, Anna University, Madras, India.

Regional Land Cover Changes Sustainable Agriculture and their Interactions with Global Change (with focus on South Asian countries). Editor Veena

Ravichandran. Foreword: Dr Rodney Nichols, President and CEO of New York Academy of Science & Chairman, COSTED. 440 pp. Price: Rs450/US\$13. Postage within India: Rs.33, outside India: US\$4. Contact: COSTED International Secretariat, 24 Gandhi Mandapam Rd, Chennai-600025, India.

This book brings forth the Proceedings of the International Workshop held in Chennai, India, between 16 and 19 December 1996, organised by the Committee on Science and Technology in Developing countries (COSTED) and funded by the European Commission. This is the outcome of COSTED's efforts to bring to the attention of the governments and the policy makers the prevailing trend towards commodity-centered land use planning leading to considerable land diversion, erosion, removal of forest canopies contributing to global changes.

The book focuses on the heavily populated Southern Asian Region where there is an urgent need to address food security through sustainable agricultural practices against this scenario. The workshop brought together 60 senior experts, government officials, policy makers and NGOs from the European Union and the Southern Asian region in the field of agriculture, land use policy and global issues.

The proceedings of the workshop brings forth the research needs and institutional capacities, regional issues, global scenario technological advances opportunities for management cooperation, networking, concerted actions and delivery systems role of government, public policies, world trade agreements,

The book provides a wealth of information on the most recent scenario in land use and sustainable agriculture for the South Asian region. The suggested readership for this book is:

- Academicians & Researchers
- Social Scientists
- Scientific Advisors to the Govt.
- Policy makers
- NGOs
- Technologists

A valuable reference for South Asian region University and research libraries. The Proceedings also includes a list of participants which enables the reader to contact the concerned person for further information on the relevant subject.

Contents

- 1 Country reports on the South Asian scenario in agriculture, land use & global change implications
- 2 Land cover changes and their driving forces
- 3 Global change scenario-current future trends
- 4 Institutional constraints and socioeconomic dimensions of land use and productivity
- 5 Panel Discussion on issues of concern to the region
- 6 Recommended action plan.