



# VCU

Virginia Commonwealth University  
VCU Scholars Compass

---

CyanoNews

---

1996

## CyanoNews (Vol. 12, No. 1, January 1996)

Jeff Elhai

*Virginia Commonwealth University*, [elhaij@vcu.edu](mailto:elhaij@vcu.edu)

Follow this and additional works at: <http://scholarscompass.vcu.edu/cyanonews>



Part of the [Bacteriology Commons](#)

© The Author(s)

---

Downloaded from

<http://scholarscompass.vcu.edu/cyanonews/7>

This Bulletin is brought to you for free and open access by VCU Scholars Compass. It has been accepted for inclusion in CyanoNews by an authorized administrator of VCU Scholars Compass. For more information, please contact [libcompass@vcu.edu](mailto:libcompass@vcu.edu).

# CYANONEWS

Volume 12 Number 1 January 1996

=====

**CONTENTS\*CONTENTS\*CONTENTS\*CONTENTS\*CONTENTS\*CONTENTS**

=====

## BULLETIN BOARD

- \* Cyanos meet the World Wide Web
- \* Summer course: Organization and Assembly of the Photosynthetic Apparatus
- \* Books
- \* Meetings
- \* Positions Sought, Positions Available

## TRANSITIONS

- \* Comings and goings of ourselves
- \* Utrecht Cyanobacterial Group

## NEWS

- \* Clue found to mystery of swimming Synechococcus
- \* Alternative to alternative oxidase
- \* Codon usage by Synechocystis PCC 6803
- \* Cyanobacteria quantitated by competitive PCR
- \* Blue-greens on the rocks
- \* Nostoc 6720 unmasked!
- \* Peptide synthetase genes found in toxic Microcystis
- \* Blue-greens bring death to millions? A possible connection with cholera
- \* New phylogenetic trees from 16S rRNA

## MEETING REPORTS:

- \* Cyanobacterial Molecular Biology Workshop
- \* Cyanobacteriology Seminar for Students

## REFERENCES

## ADDRESSES

=====

CYANONEWS - a newsletter intended to provide cyanobacteriologists with a forum for rapid informal communication, unavailable through journals. Everything you read in this newsletter is contributed by readers like yourself. Published occasionally, about three times per year.

SUBSCRIPTIONS - \$10/year for hard copy version. No charge for electronic version. See last page for details.

CONTRIBUTIONS - Expected every couple of years: a new result, an upcoming meeting or a summary of a past meeting, a post-doctoral opening, a new publication, a request for strains, a change of life... something. See last page for addresses you can send news to.

HOW TO FIND OUT MORE ABOUT SOMETHING YOU READ HERE - Each news item contains, prominently displayed, the name of a contact person. A Directory of Cyanobacteriologists is distributed every two years or on request.

INSTRUCTIONS TO AUTHORS - Send news.

COPYRIGHT - This newsletter is not copyrighted and no rights are reserved. You are encouraged to reproduce or to transmit any part of this publication by whatever means at your disposal, no permission required.

Cyanonews has been placed on-line to assist in the proliferation of this important document.

=====

=====

**BULLETIN BOARD\*BULLETIN BOARD\*BULLETIN BOARD**

=====

=====

The Web

For those of you who have experienced the World Wide Web, no explanation is necessary. For those of you who have not, no explanation is possible... nonetheless, here's an attempt. Imagine an encyclopedia that is continuously and instantaneously being updated by its readers strewn throughout the world. Each entry, or homepage, is a collection of pertinent text, graphic images, and sounds deemed appropriate by its creator, plus instant connections to other entries. You can visit a homepage and consume or even download items of interest or you can surf from connection to connection, often finding yourself far afield from where you started.

There are already several homepages of interest to cyanobacteriologists. Ben Long (La Trobe U.) is perhaps furthest along in a homepage devoted to cyanobacteriology. The focus of his homepage is TOXIC CYANOBACTERIA and currently includes:

1. A short introduction to microcystins, including diagrams
2. A description of *Microcystis aeruginosa*, including a scanning EM picture
3. Preliminary information on protein phosphatases
4. Information on Cyano-Tox, a discussion group on toxic cyanobacteria and their toxins
5. Access to Cyanonews, including back issues and the Directory of Cyanobacteriologists
6. Links to some other relevant homepages

The site is still under construction (and probably always will be), and Ben is anxious to receive feedback, submissions, and suggestions for additions. In particular, he would like contributions that update or correct any errors on the existing page and information from those who work on other cyanobacterial toxins (or secondary metabolites). Even contributions that are only tangentially related to toxic cyanobacteria are welcome, as the more information available on any topic will make the page much more useful. Some people have indicated eagerness to see pictures of their favorite cyanos. Any pictures (in GIF format) are welcome! Ben is also interested to make contact with someone well versed in HTML, the language of making web pages. The page may also be used as a bulletin board for up and coming events. Please send them in!

CONTACT: Ben Long, TEL: 61 3 9479 2771, FAX: 61 3 9479 1188 WEB:

<http://Luff.Latrobe.Edu.Au/~BotBML/Cyanotox.Html> E-MAIL:

[BotBML@Luff.Latrobe.Edu.Au](mailto:BotBML@Luff.Latrobe.Edu.Au)

=====

Mark Schneegurt (Purdue U.) is initiating a GENERAL CYANOBACTERIOLOGY web site, which should be up and running the middle of January, 1996. It will

eventually contain a searchable bibliography of cyanobacteria-related articles. Anyone with items that would be of interest -- e.g., lists of gene names, sequenced genes, etc. Mark is especially interested in protocols and teaching materials. Items can be sent to him by E-mail or FTP.

CONTACT: Mark Schneegurt E-MAIL: MSchnee@Bilbo.Bio.Purdue.Edu WEB: (to be announced)

=====

The University of Arizona, Dept. of Chemistry and Biochemistry has put together a site devoted to matters of PHOTOSYNTHESIS. WEB:

<http://aspin.asu.edu/provider/photosyn/>

=====

The University of Antwerp runs a site that collects RRNA SEQUENCES. WEB:

<http://www-rrna.uia.ac.be/>

=====

#### Matters Arising

A summer course on the ORGANIZATION AND ASSEMBLY OF THE PHOTOSYNTHETIC APPARATUS will be held 12-23 May 1996 at the Weizmann Institute, Rehovot, Israel, open to graduate and post-graduate students. The course is intended to aid students from either a biochemical or biophysical background comprehend the current state of the field and its methodological basis. The registration fee of \$200 will cover full board and tuition. Since there is a limitation of 25 participants only, those interested should apply in writing as soon as possible. The application should include a resume of studies, personal details (full name, nationality, date of birth, gender) and address details (mailing address, fax, e-mail etc.). Include also a brief (not more than 1 page) resume of present work, list of publications (if available), and letters of recommendation (preferably from at least two mentors).

CONTACT: Shmuel Malkin, Biochemistry Department, Weizmann Institute of Science, Rehovot, 76100, ISRAEL. E-MAIL: BCMalkin@Weizmann.Weizmann.Ac.IL

=====

A book entitled Detection Methods for Cyanobacterial Toxins is now available from CRC Press. The book is based on presentations at a meeting of the same name held in Bath, September 1993. The 202 page book, edited by Geoff Codd and others sells for U.S.\$89.95.

CONTACT: CRC Press, Inc., 2000 Corporate Blvd., N.W., Boca Raton, FL 33431-9868 U.S.A. TEL: 407-994-0555

=====

Some readers may not be aware that The Molecular Biology of Cyanobacteria, edited by Don Bryant and recently reviewed [Haselkorn R (1995) Science 269:1121], is just the first volume of a series, entitled ADVANCES IN PHOTOSYNTHESIS. The series, from Kluwer Academic Publishers, is intended to provide a multidisciplinary approach to the topic, spanning the range from macromolecular structure to whole

plant physiology. Volume 2 was recently released: Anoxygenic Photosynthetic Bacteria, edited by Robert Blankenship, Michael Madigan, and Carl Bauer. Future volumes include:

Oxygenic Photosynthesis: The Light Reactions (Don Ort and Charles Yocum)

Environmental Stress and Photosynthesis (Neil Baker)

Physical Methods in Photosynthesis Research (Jan Amesz and Arnold Hoff)

Lipids in Photosynthesis: Structure, Function and Genetics (Paul Siegenthaler and Norio Murata)

If you have an idea for an additional volume, then by all means pass it on to Govindjee, the series editor, at:

CONTACT: (with ideas for additional volumes) Govindjee, Department of Plant Biology, University of Illinois, 505 South Goodwin Avenue, 265 Morrill Hall, Urbana, IL 61801-3707 TEL: 217-333-1794, FAX: 217-244-7246, E-MAIL:

Gov@Pop.Life.Uiuc.Edu

CONTACT: (inquiries about published books) Kluwer Academic Publishers: E-MAIL: Services@Wkap.NL

=====

#### MEETINGS

The Jacques Monod Conference on Synthesis and Function of Photosynthetic Complexes will be held in Aussois, France, 25-29 March, 1996. Four major themes will be discussed: Expression of genes involved in photosynthesis, transport and targeting of chloroplast proteins, structure of photosynthetic complexes, and function of photosynthetic components. Interested scientists may apply by sending their CV, a one page summary of their research interests, and a list of their most relevant publications to:

CONTACT: J.D. Rochaix, University of Geneva, Department of Molecular Biology, 30, Quai Ernest Ansermet, CH-1211 Geneva 4, SWITZERLAND. E-MAIL:

Rochaix@Sc2a.Unige.Ch

=====

Participants in a two-day meeting entitled MOLECULAR TO GLOBAL PHOTOSYNTHESIS will discuss factors that govern the efficiency of solar energy conversion by oxygenic photosynthetic organisms at all levels, ranging from primary charge separation and carbon fixation to biomass production and global gas and energy balance. The meeting will be held 28-29 March 1996, at Imperial College, London, UK.

CONTACT: Jim Barber, Wolfson Laboratories, Biochemistry Department, Imperial College, London SW7 2AY, UK. FAX: 171 594 5267, E-MAIL: J.Barber@ic.ac.uk

=====

The SYMPOSIUM ON MOLECULAR PLANT-MICROBE INTERACTIONS will be held in Knoxville, Tennessee (U.S.A.) 14-19 July, 1996.

CONTACT: Gary Stacey, Director, Center for Legume Research, M409 Walters Life Science Bldg., University of Tennessee, Knoxville, TN 37996-0845, U.S.A., FAX: 615-974-4007, E-MAIL: GStacey@Utkvx.Utk.Edu

=====

As part of the 50th Anniversary Meeting of the Phycological Society of America (Santa Cruz, California, 14-18 July 1996), a one day symposium will be held on "CYANOBACTERIA AS MODEL SYSTEMS FOR STUDYING BIOLOGICAL PROCESSES". Speakers will include Bob Haselkorn (Development/Nitrogen Fixation), Arthur Grossman (Environmental Stress), Wim Vermaas (photosynthetic protein complexes), John Waterbury (ecological studies), and Susan Golden (circadian rhythms).

CONTACT: (Registration information) Paul Kugrens, PKugrens@Lamar.ColoState.Edu

CONTACT: (Symposium information) Brian Palenik and Bianca Brahamsha, Scripps Institution of Oceanography, U.C.S.D. La Jolla CA 92093-0202 U.S.A. TEL: 619-534-7505, FAX: 619-534-7313, E-MAIL: BPalenik@Ucsd.Edu

=====

A meeting designed to bring together investigators who apply modern techniques to the study of diverse SYMBIOTIC ASSOCIATIONS is scheduled on 5-8 Sept 1996 in Bar Harbor, Maine.

CONTACT: Scott O'Neill, Dept. of Epidemiology and Public Health, Yale University School of Medicine, P.O. Box 3333, New Haven, CT 06510 U.S.A. TEL: 203-785-3285, FAX: 203-785-4782, E-MAIL: Scott\_ONeill@Quickmail.Yale.Edu, WWW: <http://Wolbachia.Med.Yale.Edu>

=====

Those who like their nitrogen meetings without competition from Rhizobia might check out the 7th INTERNATIONAL SYMPOSIUM ON BIOLOGICAL NITROGEN FIXATION WITH NON-LEGUMES 16-21 October 1996 in Pakistan.

CONTACT: National Institute for Biotechnology and Genetic Engineering (NIBGE) P.O. Box 577, Jhang Road Faisalabad, PAKISTAN, TEL: 41-65-1471 or 41-651475-79, FAX: 41-65-1472, E-MAIL: Kauser@Nibge.Lke.imran.Pk

=====

An INTERNATIONAL SYMPOSIUM ON CYANOBACTERIAL BIOTECHNOLOGY will take place 18- 21 Sept 1996 in Tiruchirapalli, India. The emphasis of the meeting will be on environmentally sustainable utilization of cyanobacteria for human welfare.

CONTACT: G. Subramanain, Director, NFMC, Bharathidasan University, Tiruchirapalli - 620 024, INDIA. TEL: 91-431-60352, FAX: 91-431-60245 or 91-431-60320, E-MAIL: bdasan@iitm.ernet.in

=====

The 11TH AUSTRALIAN NITROGEN FIXATION CONFERENCE will focus on N<sub>2</sub>-fixing symbioses at its meeting in Perth, Australia, 22-27 September 1996. While

the conference will stress the role of leguminous plants in sustainable agriculture, cyanobacterial symbioses may also find a place.

CONTACT: The Secretary, Australian Society for Nitrogen Fixation, Centre For Legumes in Mediterranean Agriculture, University of Western Australia, Nedlands, W.A. 6907, AUSTRALIA. FAX: 61-9-380-1140, E-MAIL: Asnf@Cyllene.Uwa.Edu.Au

=====

#### POSITIONS SOUGHT

POSITION SOUGHT: Post-Doc CONTACT: Sridharan, Govindachary, #6, Sait Colony 1st Street, Egmore, Madras 600008, INDIA, FAX: 00-91-44-8257454

RESEARCH EXPERIENCE AND INTERESTS: 12 years in cyanobacterial photosynthesis, nitrogen fixation, nitrogen assimilation, mutagenesis, selection of herbicide resistant strains, outdoor cultivation of algae, biochemistry and molecular biology POST-DOC EXPERIENCE: 17 months each in India and Israel

=====

#### POSITIONS OFFERED

POSITION OFFERED: Post-Doc CONTACT: J. Nugent, Department of Biology, University College London, Gower Street, London WC1E 6BT, U.K. TEL: 0171-380-7098, FAX: 0171-380-7096, E-MAIL: J.Nugent@UCL.Ac.Uk RESEARCH: Join multidisciplinary team to study the biogenesis and functioning of photosystem II in wild-type and mutant strains of Chlamydomonas and cyanobacteria. SALARY: Three year position, within the range UK 14,317 - 17,466 (plus 2,134 London allowance) SEND: CV and names of two referees

=====

POSITION OFFERED: Post-Doc CONTACT: Jim Golden, Department of Biology, Texas A&M University, College Station, TX 77843-3258 USA. TEL: 409-845-9823, FAX 409-845-2891, E-MAIL: JGolden@Tamu.Edu RESEARCH: Regulation and mechanism of programmed DNA rearrangements during heterocyst differentiation in Anabaena sp. strain PCC 7120 REQUIREMENTS: Expertise in molecular biology, biochemistry, and microbial genetics. Strong preference will be given to individuals with a proven record of quality publication and to those with potential for obtaining independent funding AVAILABLE: immediately SEND: CV and three letters of recommendation

=====

**TRANSITIONS\*TRANSITIONS\*TRANSITIONS\*TRANSITIONS\*TRANSITIONS**

=====

ED CARPENTER is spending a year or two in Washington at the National Science Foundation's Office of Polar Programs. He is still connected to his old lab at State University of Stony Brook.

E-MAIL: ECarpent@Nsf.Gov

=====

ANDREY DEMIDOV has moved operations from David Andrews lab in East Anglia, U.K., where he worked on polarization spectroscopy in molecular systems with energy transfer. He is now in the U.S. using femtosecond spectroscopy to study primary processes of excitation energy migration and electron transfer in reaction center of photosystem-II.

Physics Department, University of Michigan, 500 E.University, 2071 Randall Lab., Ann Arbor, MI 48109-1120, U.S.A. TEL: 313-763-0998, FAX: 313-665-1345, E-MAIL: ADemidov@UMich.Edu, WEB: <http://www.umich.edu/~ademidov>

=====

DIRK GEERTS defended his Ph.D. thesis last June, entitled Genetic modification of photosynthesis in the cyanobacterium *Synechococcus* sp. PCC7942: gene expression and protein transport. With the demise of the cyanobacterial group at Utrecht (see below), Dirk has taken a post-doc position in Amsterdam, studying integrins and their role in tumorigenesis. Though happy with his position, he laments that his cultures have the wrong color: now red instead of blue-green. On days off and weekends he still teams up with Hans Matthijs (U. Amsterdam) doing physiology experiments on the phycocyanin production in *Synechococcus* PCC 7942. This offers some compensation.

Division of Cell Biology, The Netherlands Cancer Institute, Plesmanlaan 121, 1066 CX Amsterdam, NETHERLANDS, TEL: 31-20-512.1942, FAX: 31-20-512.1944, E-MAIL: DGeerts@Nki.NL

=====

MASAHIRO ISHIURA and TAKAO KONDO have both moved from the National Institute of Basic Biology in Okazaki to Nagoya. Both will continue their work on cyanobacterial circadian rhythm.

Department of Biology, Faculty of Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya, 464-01 JAPAN, TEL: 81-52-789-2495, E-MAIL: ishiura@Bio.Nagoya-U.Ac.Jp

=====

SVEN JANSON is a new Ph.D., having defended his thesis Cell structure and localizatoin of nitrogenase in some marine and brackish cyanobacteria. For the moment he remains in Birgitta Bergman's laboratory.

Department of Botany, Stockholm University, S-106 91 Stockholm, SWEDEN, TEL: 46-8-16 13 26, FAX: 46-8-16 55 25, E-MAIL: Jansons@Botan.Su.Se

=====

BART NELISSEN last July defended his doctoral thesis entitled Phylogenetic study of the cyanobacteria on the basis of 16S RRNA gene sequence analysis (See NEWS). He remains at:

Departement Biochemie, Universiteit Antwerpen (U.I.A.), Universiteitsplein 1, B-2610 Wilrijk (Antwerpen), BELGIUM, TEL: 32 3 820 23 05, FAX: 32 3 820 22 48, E-MAIL: Nelissen@Uia.Ua.Ac.Be, WEB: <http://www.uia.ac.be/u/nelissen>

=====

YASUYUKI NEMOTO has returned to Japan, having left University of Miami where he had worked in the laboratory of Akira Mitsui on hydrogen production from cyanobacteria.

Dept. Biotechnol., Fac. Technol, Tokyo University of Agriculture and Technology, 2-24-16 Naka-machi, Koganei, Tokyo 184, JAPAN, TEL: 81-423-88-7030, FAX: 81-423-88-7205, E-MAIL: YNemoto@Cc.Tuat.Ac.Jp

=====

GEORGE OWTTRIM has returned to the fold after a post-doc in Switzerland with Cris Kuhlemeier working on translation initiation factors in tobacco, particularly RNA helicase proteins. He now has a faculty position and intends to exploit his expertise with helicase proteins to their study in cyanobacteria.

Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9, CANADA, TEL: 403-492-1803, FAX: 403-492-9234, E-MAIL: G.Owttrim@UAlberta.Ca

=====

ERIK SODERBACK has returned to Bergitta Bergman's group after a sojourn in England working on regulation of nitrogen fixation genes in the laboratory of Ray Dixon. He has lost little time in recovering his ardor for symbiotic cyanobacteria. Department of Botany, Stockholm University, S-106 91 Stockholm, SWEDEN, TEL: 46-8 16 38 46, FAX: 46-8 16 55 25, E-MAIL: Soderbac@Botan.Su.Se

=====

Utrecht Cyanobacterial Group (1975-1995)

We regret to learn of the passing of the Utrecht cyanobacterial group, which accomplished as much as any group in the development of cyanobacterial molecular genetics. Their pioneering work made possible many of the techniques of gene replacement in cyanobacteria that we take for granted today. The group outlived its founder, Gerard van Arkel, by less than a year -- van Arkel died December 1994, four years after his retirement.

The former affiliates of the group have dispersed as follows: PETER WEISBEEK continues to lead the Section Molecular Genetics, which now focuses solely on plant studies. MIES BORRIAS remains in the Section and will extend her work on gene expression to higher plants. GEERT DE VRIEZE, the senior technician, now works with Ben Scheres on root development. ARNAUD BOVY has left to take a post doc position in Wageningen, where he works to improve several cultured plants,

including carnation. DIRK GEERTS also has left, taking a post-doc position in the Netherlands Cancer Institute in pursuit of the processes underlying cell adhesion.

=====  
**NEWS\*NEWS\*NEWS\*NEWS\*NEWS\*NEWS\*NEWS\*NEWS\*NEWS\*NEWS\*NEWS**  
=====

#### Clue Found to Mystery of Swimming Synechococcus

Several years ago John Waterbury and coworkers [Science (1985) 230:74- 76] reported on the ability of certain marine Synechococcus to swim without apparent benefit of flagella or any other discernible aid. Bianca Brahamsha now tells us she is beginning to get a handle on the question of how they move. Biochemical studies showed that the loss of motility following treatment of cells with proteinase K correlates with the loss of an abundant 120-Kd outer membrane protein. The gene encoding the protein was cloned by a reverse genetics approach, but the sequence gave little indication as to function. After establishing a means of introducing foreign DNA into Synechococcus WH8102, Bianca knocked out the 120-kd outer membrane polypeptide,... and the cells don't swim. They still rotate about their longitudinal axis, but they don't go anywhere, as though they're missing a rudder or something. Of course, this could be an indirect effect -- if they can't make a proper outer membrane, motility components may not be able to insert correctly. Nonetheless, she is excited because for the first time a system is in hand to dissect swimming motility in cyanobacteria.

CONTACT: Bianca Brahamsha, Scripps Institution of Oceanography, Univ. of California-San Diego, La Jolla CA 92093, U.S.A. TEL: 619-534-7505, FAX: 619-534-7313, E-MAIL: BBrahamsha@Ucsd.Edu

=====

#### Alternative Alternative Oxidase

Alternative respiration (as defined by cyanide-insensitive oxygen consumption) has long been known in cyanobacteria. Guenter Peschek sent in some results from his group that call into question exactly what we mean by "alternative". Using reverse phase HPLC, his group was able to identify heme B (associated with cytochrome b) and lesser amounts of hemes A (associated with aa3-type cytochrome c oxidase) and O from chlorophyll-free cytoplasmic membranes of both unicellular and filamentous cyanobacteria. Heme O was observed only in cultures grown semi-anaerobically. Surprisingly, monospecific antibodies raised against aa3-type cytochrome oxidase (from *Paracoccus denitrificans*) and against bo3-type quinol oxidase (from *E. coli*) both recognized the same band on denaturing gels of cytoplasmic membrane protein from cultures, whether or not grown anaerobically. The band comigrated with subunit-I protein of cyanobacterial cytochrome c oxidase. Perhaps heme A and heme O both combine with the same apoprotein, depending on the oxygen-dependent availability of the two hemes. If so, then "aa3-type" and "o3-type" oxidases may represent not "alternative oxidases" in the usual sense of the word but rather alternative hemes. This work has been recently published [Auer et al (1995) *Biochem Mol Biol Internatl* 37:1173-1185].

CONTACT: Guenter Peschek, Institute of Physical Chemistry, University of Vienna,  
Waehringerstrasse 42, A-1090 Wien, AUSTRIA, TEL: 43-1-343616, FAX:  
43-1-3104597

=====

#### Codon Usage by Synechocystis PCC 6803

##### Codon Usage Chart

Each codon is followed by a number representing the fraction of instances the amino acid is encoded by the triplet. The second number represents the frequency with which the codon appears on average per 1000 amino acids. The table is based on 10781 codons from sequenced genes of Synechocystis PCC 6803.

CONTACT: Nigel Silman, Biological Sciences, University of Warwick, Coventry, CV4 7AL, U.K., FAX: 203-523701, E-MAIL: [Lsrew@Csu.Warwick.Ac.Uk](mailto:Lsrew@Csu.Warwick.Ac.Uk)

=====

#### Competitive PCR to Quantitate Cyanobacteria

Enumeration of low density cyanobacterial populations is a chancy business, and choices range from the unreliable (plating), to the tedious (microscopy) and horrifically expensive (flow cytometry). Janet Jansson's group recently provided another choice, monitoring luminescence from cyanobacteria tagged with luc, encoding firefly luciferase [Moeller et al (1995) FEMS Microbiol Lett 129:43-50]. Using tagged Synechocystis PCC 6803, they were able to quantitate as few as  $4 \times 10^3$  cells per g sediment from a microcosm of Baltic Sea water. Tagged cyanobacteria can also be detected by PCR, taking advantage of the fact that luc is unknown in natural microbial populations, but direct PCR has little quantitative value. Janet now reports that her group has developed a competitive PCR technique that permits quantitation of luc-tagged cyanobacteria in sediment.

The method, soon to be published [Jansson and Lesser (1995) In: Molecular Microbial Ecology Manual, Kluwer Academic Publishers, Dordrecht, Ch. 2.7.4], relies on an internal competitive standard that differs from luc by an additional 35 bp insertion. Otherwise, the target and internal standard are similar and amplified by the same primers during PCR. Using a known concentration of internal standard DNA it is possible to quantitate the original target DNA concentration by the ratio of the amplified products on a gel. The method isn't quite as simple as it sounds, since it is necessary to match the sample to a standard at a comparable concentration, but taking such precautions permitted a very accurate quantitation of luc-tagged Synechocystis in sediment [Moeller and Jansson, manuscript in preparation].

CONTACT: Janet Jansson, Department of Biochemistry, Stockholm University, S-10691 Stockholm, SWEDEN, TEL: 46-8-16-2469, FAX: 46-8-15-3679, E-MAIL: [Janet@Biokemi.Su.Se](mailto:Janet@Biokemi.Su.Se)

=====

#### Blue-greens on the Rocks

Many of our nonscientific friends know of us vaguely as experts on some sort of algae, and so we are occasionally called upon to identify biological encrustations that

we may encounter in daily life. Often we can only respond, lamely, "Looks like green goo to me." Mariona Hernandez-Marine has come to our aid, providing us with a guide to cyanobacteria and algae we might find on buildings and monuments [Ortega-Calvo et al (1995) *Sci Total Environ* 167:329- 341]. The most commonly encountered cyanobacteria in such places are filamentous species of the genera *Phormidium* and *Microcoleus*. We should also point out to our friends that what may appear as very similar blotches of green on the bricks and mortar between them are likely to be quite different communities, owing to a surprising degree of microclimatic variability.

Care must be taken to distinguish such growth from the black sulfated crusts that accumulate on limestone buildings as a result of sulfur dioxide pollution of the air. Even here, however, we must tell our friends that cyanobacteria, particularly of the genus *Gloeothece*, can thrive on the crusts, despite the presence of toxic compounds, and may provide nutrients for growth of other bacteria.

Some of us may also find ourselves on occasion groping for conversation within dark caves. Here too, Mariona has saved us from a potentially embarrassing assertion, that the grey mat on cave walls could not possibly be due to cyanobacteria. In fact, she tells us, cyanobacteria are amongst the cave's most important epilithic vegetation, despite the very low levels of light. Her description of a calcified cyanophyte of the genus *Herpysonema* (*Mastigocladaceae*) has recently been published [*Algol Studies* (1994) 75:123- 136].

Needless to say, this report only scratches the surface. For further information...

CONTACT: Mariona Hernandez-Marine, Laboratory of Botany, University of Barcelona, E-08028 Barcelona, SPAIN, TEL: 34 3 4024490, FAX: 34 3 4021886, E-MAIL: [Hernande@Far.Ub.Es](mailto:Hernande@Far.Ub.Es)

=====

Nostoc 6720 unmasked!

John Smith has alerted us to the fact (pointed out to him by Terry Thiel) that the cyanobacterium he has been calling Nostoc 6720 is more likely to be a species of *Anabaena*. He confirmed this by comparing the PCR products amplified from genomic DNA, using HIP sequences [Robinson et al (1995) *Nucl Acids Res* 23:729-735] as primers (courtesy of Nigel Robinson), with those amplified from DNA from Nostoc MAC and *Anabaena* PCC 7120. Comparison of the *nifH* sequence from "Nostoc 6720" with the sequence derived by Martin Mulligan from *Anabaena variabilis* ATCC 29413 suggests that the former strain is closely related to the latter. In fact, stock records identify the cyanobacterium as *Anabaena* PCC 7937 (nominally identical to ATCC 29413), and the confusion occurred in 1985 when both cyanobacteria were obtained from the Pasteur collection for work on synchronous akinete germination.

CONTACT: John Smith, Dept. of Biological Sciences, University of Lancaster, Bailrigg, Lancaster LA1 3JC, U.K. TEL: 0524-65201, FAX: 0524-843854, E-MAIL: [R.Smith@Lancaster.Ac.Uk](mailto:R.Smith@Lancaster.Ac.Uk)

=====

### Peptide Synthetase Genes Found in Toxic Microcystis

Many have yearned for the day when the power of bacterial genetics could be applied to the task of elucidating the biosynthetic pathways leading to toxic peptides made by cyanobacteria. The goal has proven to be elusive, however, and until that day arrives, we will have to rely on clever tricks and deductions. Tom Boerner's group at Humboldt University has used both to clone several peptide synthetase genes from *Microcystis aeruginosa* and to identify a molecular marker for toxic strains.

They exploited the fact that peptide synthetases studied in Gram- positive bacteria and fungi share two highly conserved adenylate-forming domains. Using primers derived from these domains, the Berlin group obtained four different PCR products, two each from DNA of the toxic *M. aeruginosa* strains HUB 524 and PCC 7820. All four showed striking sequence similarity to peptide synthetase genes. One of the products hybridized to DNA from three tested toxic strains but not to three tested nontoxic strains. That product was used to identify corresponding sequences from genomic libraries, and the 2982 bp sequence of the region (deposited in the EMBL data base with accession number Z28338) showed extended amino acid sequence similarity to peptide synthetases, particularly to the proline-activating synthetase unit of gramicidin S synthetase from *Bacillus brevis*.

Their results, soon to appear in FEMS Microbiological Letters, indicate that toxic *Microcystis* may utilize nonribosomal peptide synthesis of the type used to synthesize other peptide toxins. Furthermore, toxic strains may differ from nontoxic strains in part by the presence of a gene or genes required for the synthesis.

CONTACT: Tom Boerner, Institut fuer Biologie, Humboldt-Universitaet, Invalidenstr. 43, D-10115 Berlin, GERMANY, TEL: 49-30-28 97 26 33, FAX: 49-30-28 97 27 99, E-MAIL: Thomas=Boerner@Rz.Hu-Berlin.De

=====

### Cholera Connected to Blue Green Blooms?

Cholera, once confined largely to the Indian subcontinent, has in the last 200 years become a world disease. The disease has swept through much of humanity in a succession of waves, the last major pandemic initiating in 1961. In between incidents of mass infection, *Vibrio cholerae*, the causative agent, must reside in some still unknown environmental reservoir. It may be pertinent that the peak incidence of cholera in Bangladesh coincides with the appearance of cyanobacterial blooms. Some have postulated that algae and cyanobacteria may in fact constitute the unknown reservoir [Epstein (1993) *BioSystems* 31:209], pointing to the ability of *V. cholerae* to survive long periods in the slime produced by these organisms.

Igor Brown has proposed a different connection between cyanobacteria and *V. cholerae*. He points out that growth of members of the Vibrionacea is stimulated by induction of sodium cycle energetics [Bakeeva et al (1986) *Biochim Biophys Acta* 850:466]. Brown's own work has suggested that the growth of cyanobacteria in

brackish water is autocatalytic: sodium plus alkalinity stimulate the sodium cycle in cyanobacteria, and the resulting growth increases the alkalinity [Brown et al (1990) Biol Membr 4:2039; unpublished results]. The alkalization and the accompanying increase in dissolved organic compounds resulting from the bloom may induce the sodium cycle in the Vibrionacea, including *V. cholerae*. Dissemination of the disease would then occur as water from the bloom is used or dispersed.

Whether or not Brown's suggestion is correct, it is comforting to know that cyanobacteria may participate in matters of utmost importance to humans and their funding agencies, quite apart from the prosaic tasks of maintaining the atmosphere and the food chain.

Igor would love to cooperate with anyone in a position to test his idea.

CONTACT: Igor Brown, Cyanobacter Biol. Res. Lab, Odessa State University, Petr Velikiy St. 2, Odessa 270100, UKRAINE, TEL: 007-0482-68-77-93, FAX: 007-0482-23-82-88, E-MAIL: IBrown@Microalgae.Odessa.Ua

=====

#### New Phylogenetic Trees from 16S rRNA

This past summer Bart Nelissen (U. Antwerpen) defended his doctoral thesis entitled Phylogenetic study of the cyanobacteria on the basis of 16S rRNA gene sequence analysis. Nearly complete 16S rRNA sequences of eleven cyanobacteria belonging to different morphological groups were determined from cloned PCR-amplified products to gain a better understanding of cyanobacterial phylogeny. A cyanobacterium-specific oligonucleotide probe was developed to distinguish cyanobacterial 16S rRNA sequences from amplified products originating from contaminating bacteria. Phylogenetic trees were constructed using the cyanobacterial sequences aligned with other previously determined sequences. The thesis addressed the phylogenetic relationships between filamentous helical cyanobacteria (*Spirulina* and *Arthrospira*) and between cyanobacteria and plastids, and the homogeneity of the genera *Pseudanabaena* and *Leptolyngbya*. Most of the results have been published [Nelissen et al (1994) Syst Appl Microbiol 17:206-210; Nelissen et al (1995) Mol Biol Evol 12:1166-1173; Nelissen et al (1996) J Mol Evol in press].

CONTACT: Bart Nelissen, Dept. Biochemie, Universiteit Antwerpen (U.I.A.), Universiteitsplein 1, B-2610 Wilrijk (Antwerpen), BELGIUM, TEL: 32-3-820-23-05, FAX: 32-3-820-22-48, E-MAIL: Nelissen@Uia.Ua.Ac.Be

=====

## Meeting Reports

By their very nature, meeting reports are just snapshots of what occurred. A different angle would produce a very different view. The two reports below can only provide a flavor of some of the advances that have taken place.

=====

### Vth Cyanobacterial Molecular Biology Workshop

The Vth Cyanobacterial Molecular Biology Workshop was held again at Asilomar, California, July 21-25. Asilomar has become the permanent home, as the next meeting in 1998 is also scheduled for the site on the Pacific Ocean. Many thanks to Don Bryant and Neil Straus for organizing the meeting.

### Photosynthesis

Pradip Manna (Arizona State U.) reported the involvement of luminal cytochromes on electron transport in a PSI-LESS MUTANT of *Synechocystis* PCC 6803. Of particular interest was the important but not essential role of cytochrome c553 in mediating the PSII-dependent flow of electrons to the terminal oxidase. Gaozhong Shen (Pennsylvania State U.) also reported PSII activity in a PSI-less mutant from *Synechococcus* PCC 7002. His results suggested that PSII-generated electrons can be transferred to NAD through NADH dehydrogenase and that this process seems to be regulated by light. On the PSI side, Shen also described his success in deleting *psaC* and *psaD* genes from *Synechococcus* PCC 7002. Both mutants showed hypersensitivity to light intensity and both mutants showed much lower PSI reaction center content. The construction of these mutants opens a new way to further analyze protein structure and function of PSI.

Jian-Ren Shen (RIKEN) presented evidence that CYTOCHROME C550 is a critical component of PSII located on the luminal side of thylakoids in *Synechocystis* PCC 6803. When the gene encoding cytochrome C550 was deleted, a much lower growth rate as a result of slow down of PSII electron transport was observed. Dave Krogmann (Purdue U.) also reported cloning of the *petK* gene, encoding cytochrome C550. His results indicate that the cytochrome might be involved in H<sub>2</sub> production. Progress in understanding CYTB6/F FUNCTION was presented by Toivo Kallas (U. Wisconsin, Oshkosh). His group evaluated the function of specific amino acids in cytochrome b<sub>6</sub> (encoded by *petB*) and subunit IV (encoded by *petD*) by introducing site-specific mutations into *Synechococcus* PCC 7002. Kallas also reported reconstitution of Rieske center from overproduced apoprotein. Functions of low potential cytochrome c were reported by two groups.

The regulation of CHLOROPHYLL-BINDING PROTEIN SYNTHESIS with *chlL*-mutant was described by Qingfang He (Arizona St. U.). When the *chlL* gene was deleted, chlorophyll synthesis became totally dependent on light. In darkness, protochlorophyllide accumulated. This mutant should provide a good system to study chlorophyll synthesis and its regulation.

Several presentations focused on CO<sub>2</sub> FIXATION. Michael Zianni (Ohio State U.) described the disruption of the *rca* gene of *Anabaena variabilis*, encoding RubisCO

activase. The resulting strain lacked activase and showed a marked change in RubisCO activity and growth under certain conditions. Dean Price and Dieter Sueltemeyer (both of Austral. Natl. U.) discussed different aspects of the CO<sub>2</sub>-concentrating mechanism encoded by *ccm* genes in *Synechococcus* PCC 7002. The genes have now been cloned. Curiously, a *psaE*- strain lacking cyclic electron flow around PSI was unable to induce high affinity transport system for bicarbonate under low CO<sub>2</sub> conditions. The authors suggested that *psaE*-dependent cyclic electron flow may be important in energizing or inducing bicarbonate transport.

#### Physiology

Carol Andersson (Texas A&M U.) presented the results of an international coalition of workers studying the molecular basis of CIRCADIAN RHYTHMS in *Synechococcus* PCC 7942. *Synechococcus* and other cyanobacteria remain the only prokaryotes with documented circadian rhythms. Using random transcriptional fusions to *luxAB*, encoding bacterial luciferase, and an automated image processing system, the group recorded the amplitude and periodicity expression of 6000 reporter fusions. Almost all 800 colonies that were bright enough to monitor showed rhythmic expression of luminescence, suggesting that circadian regulation is surprisingly common. A screen of integrational mutants for colonies defective in the rhythmic expression of *psbAI* yielded one with a low amplitude phenotype. The affected gene, which turned out to be a member of the sigma-70 family, affected some but not all circadian-regulated genes. Chemical mutagenesis yielded period length mutants that displayed a wider range of periodicity than previously observed in any other organism. Complementation analysis of chemically induced mutants indicates that 80% of these mutations lie in the same region of the chromosome, which may contain the gene(s) for the clock machinery.

Nick Mann (U. Warwick) presented the efforts of his group on the characterization of MEMBRANE ASSOCIATED KINASE activities in cyanobacteria. In *Synechocystis* PCC 6803, kinase activity is activated by dark or the presence of metabolizable carbon and appears to be related to the switch off of the carbon dioxide concentrating mechanism. The kinase has several targets, and characterization of an 18-kD target by protein sequencing indicated that it was beta-phycoerythrin. The phosphorylated phycobiliprotein no longer fluoresces. The physiological role of phycobiliprotein phosphorylation is still obscure but may have to do with regulating energy flow through the photosystems. Characterization of other targets is currently underway.

Participants keenly felt the absence of David Laudenbach (U. Western Ontario), who died suddenly of complications from surgery just a month before the meeting. It was his presence, however, that was evident during the talk on SULFUR-CONTROLLED GENES given in his place by his student Mary Lou Nicholson. She described the isolation and localization of the regulatory gene *cysR* on a 50-Kb plasmid from *Synechococcus* PCC 7942. Several open reading frames (ORFs) were also found on this plasmid that are transcriptionally regulated by sulfate deprivation, mediated

through CysR. These ORFs were characterized and identified as *srpA*, *srpB*, *srpC* (*srp* = sulfur regulated plasmid-encoded), and *ggt*, encoding, respectively, catalase, a Mg transport ATPase, a protein involved in chromate resistance, and gamma-glutamyl transferase (related to glutathione).

#### Ecology and Evolution

A couple of groups reported their results on responses by cyanobacteria to NUTRIENT DEPRIVATION. Jackie Collier and Brian Palenik (Scripps Inst. Oceanography) described the utilization of urea by a marine *Synechococcus*. They cloned and sequenced urease genes from several marine cyanobacteria and showed that its expression in *Synechococcus* WH7805 is not repressed by NO<sub>3</sub><sup>-</sup> and NH<sub>4</sub><sup>+</sup>. Neil Straus (U. Toronto) reported cloning and sequencing of a gene involved in iron repression of some genes. It was 41% similarity to regulatory protein Fur from *E. coli* and had a putative Fe-binding domain.

Jack Meek's group (U. California-Davis) found two transposon-generated mutants of *Nostoc* ATCC 29133 that have lost the ability to enter into SYMBIOSIS with the hornwort *Anthoceros punctatus*. Both mutants also are Fox<sup>-</sup>, i.e. unable to fix nitrogen in the presence of oxygen. It was previously thought that all Fox<sup>-</sup> mutants would be physiologically complemented by the anaerobic environment of the symbiotic cavity in the plant tissue and, therefore, be Sym<sup>+</sup>. One of the mutants, UCD307, is defective in heterocyst glycolipid production and the protein encoded by the interrupted ORF shows similarity to polyketide synthesis pathway enzymes and some similarity to HetO and HetQ. Most interesting is the high similarity to fix-23, a locus from *Rhizobium meliloti* involved in host-symbiont recognition. Perhaps the gene product of the ORF interrupted in UCD307 is involved in production of both heterocyst glycolipid and symbiotic recognition determinants. Both compounds may be synthesized by a common pathway.

Several interesting reports on the MOLECULAR EVOLUTION OF CYANOBACTERIA and chloroplasts appeared in this meeting, with gratifying agreement in their conclusions. Sean Turner (Louisiana St. U.) presented a statistical analysis of small subunit rRNA base composition and concluded that plastids are monophyletic. Nadia Dolganov (Stanford U.) told of the cloning of a gene from *Synechococcus* PCC 7942 whose product resembles chlorophyll a/b binding protein. This result supports the idea that there was only one original endosymbiosis event. Tanja Gruber (Pennsylvania St. U.) showed a phylogenetic tree based on the amino acid sequences of sigma factors. The tree agrees with Sean's 16S rRNA data. Vickie Stirewalt (Pennsylvania St. U.) reported that their long struggle of sequencing the whole cyanelle genome is finally over. The circular DNA is comprised of 135599 bp with a low G+C content (30.4%). It contains about 192 genes and ORFs and has two inverted repeats. The inverted repeats and gene organization of this genome also supports the idea that all plastids are monophyletic.

The situation is less clear with RBCL. Bob Tabita (Ohio St. U.) presented sequences from an oceanic strain *Synechococcus* WH7803. The deduced amino acid

sequences indicated a close relationship to RbcL from purple bacteria. The importance of this finding in molecular evolution of photosynthetic bacteria remains to be elucidated.

#### Heterocyst Differentiation

Bob Haselkorn (U. Chicago) gave a talk concerning the role in heterocyst differentiation by *Anabaena* PCC 7120 of genes that bear similarity to those encoding response regulators and sensor kinases of TWO-COMPONENT REGULATORY SYSTEMS. PCR primers directed at conserved regions in the histidine kinase sensors of other two component systems amplified a series of products, denoted ask, with similarities to phoR, ntrB, pleC, and other sensory kinases. Preliminary results show that askA, which is most similar to sensory kinase phoR (which regulates phosphate deprivation genes), shows no phenotype when inactivated, and askC, most similar to pleC (required by *Caulobacter* for differentiation), alters heterocyst frequency when inactivated.

Jack Meeks (U. California, Davis) described a mutant (UCD311) evidently defective in the RESPONSE REGULATOR side of a two-component regulatory system. The gene, devR, was found by transposon mutagenesis of *Nostoc* ATCC 29133. The mutant is unable to fix nitrogen in the presence of oxygen (Fox-) but is symbiotically competent. The DevR gene product represents a different class of response regulators than PatA, a previously characterized gene from *Anabaena*, and is more closely related by sequence to response regulators CheY and SpoOF (involved in chemotaxis in *E. coli* and sporulation in *Bacillus*, respectively).

Bill Buikema (U. Chicago) discussed results concerning the ROLE AND EXPRESSION OF HETR, a gene required early in heterocyst differentiation, using a fusion of hetR to green fluorescent protein (GFP) to examine cell-specific expression. In wild type *Anabaena* PCC 7120, a high level of fluorescence from hetR::GFP was seen in well-spaced cells prior to morphologically visible differentiation. When the fusion was placed in hetR, patA, or patB mutant strains, aberrant patterns of fluorescent cells are seen. The use of GFP does carry technical limitations: the protein is toxic and requires oxygen for proper folding. Detection of gene fusions in heterocysts is therefore problematic.

Terry Thiel (U. Missouri, St. Louis) presented a different approach to analyzing the cell-specific gene expression of TWO MOLYBDENUM-DEPENDENT NITROGENASES encoded by gene clusters nif1 and nif2 in *Anabaena variabilis* ATCC 29413. She and her co-workers utilized C12-fluorescein-beta-D-galactoside, a substrate for beta-galactosidase, to localize expression of nifH1::lacZ and nifH2::lacZ fusions by fluorescence microscopy. The results indicate that the nif1 gene cluster is regulated developmentally and expressed only in heterocysts while the nif2 genes are expressed in all cells in response to nitrogen limitation and anoxia. Unpatterned expression of nif2 in vegetative cells, and, presumably, ammonia production in all cells did not prevent patterned heterocyst differentiation,

suggesting that products of nitrogen fixation may not be involved in pattern formation.

This and other provocative results presented at the meeting prompted an informal roundtable discussion to consider approaches to studying heterocyst pattern formation. The discussion centered on the question of how to determine whether or not a PRE-PATTERN OF CELLS destined to become heterocysts exists in a nitrogen replete filament. Any pattern -- pre- or post-nitrogen stepdown -- that relies on the exchange of signal molecules should be disrupted in a strain that lacks intercellular communication. We should be able to detect in such a strain any intrinsic pattern (i.e. independent of interaction) that may exist. Does such a strain exist? Perhaps, and fluorescent dyes conceivably could be used to test putative communication-less strains.

- Tom Hanson & ZHAO Jindong

=====

## 2nd Cyanobacteriology Seminar for PhD Students

In 1994, Konstanze Mez and Beatrix Falch from the University of Zurich, Switzerland, were inspired to arrange a meeting of German-speaking PhD students. The very positive impressions from that meeting led to a second edition this past September in Vienna, Austria. Seventeen young scientists followed the invitation of Wolfgang Gregor, PhD student in the group of Georg Schmetterer, and discussed the results of their present work.

### Toxicology and secondary metabolism

Juergen Steiner from the Loeffelhardt group (Wien) presented interesting results concerning the MEMBRANE INSERTION of the nuclear-encoded cytochrome c553 from cyanobacteria of *Cyanophora paradoxa*. They isolated the protein and the corresponding nuclear gene. Since the mature protein is located in the thylakoid lumen, it has to traverse three biological membranes (inner and outer envelope membranes, thylakoid membrane) and the peptidoglycan layer before it reaches its final subcellular locale. The transit sequence is composed of two different targeting signals, and this represents the first known bipartite transit sequence of a cyanobacterial protein.

Olaf Neuschaefer-Rube (Konstanz) studies a *Synechocystis* mutant isolated from the Bodensee that doesn't form normal PHYCOBILISOMES but rather contains a paracrystalline structure made up of phycocyanin and linker protein. Biochemical analysis of the crystal showed the presence not only of phycocyanin alpha and beta, but also of the rod linker LR35 C-PC. A colored polypeptide of 55 kD turned out to be a fusion protein of the rod linker at the n-terminus and a phycocyanin beta subunit. The protein is not predicted by the arrangement of genes in the mutant, indicating that a posttranscriptional event may be responsible for this strange fusion protein. Stefan Schmitz (Bonn) investigated Anabaena FERREDOXIN-BINDING PROTEINS in *E. coli* in order to find out if they possess a common binding domain for ferredoxin. All negatively charged and conserved amino acid residues of ferredoxin from

Anabaena were exchanged for neutral residues and the effects on binding to different redox partners were studied. Glu94 was identified as the most important among these residues, and for FNR and nitrite reductase an aromatic residue in position 65 also was essential. After having cloned petF gene (encoding FNR) from Anabaena variabilis, Stefan produced site specific mutations within that protein. He exchanged positively charged residues against neutral ones. Arg153, Lys209, Lys212, and Lys430 turned out to be very important, they are supposed to be lying in a cavern which binds ferredoxin. Such a cavern carrying a lot of positively charged residues could be found in several cyanobacterial nitrite and nitrate reductases. Markus Geisler (Duesseldorf) characterized the p-type CALCIUM ATPASE from the same strain. The enzyme is localized in the cytoplasmic membrane and is more closely related to eukaryotic ATPases than to bacterial ones.

Josef Niederberger (Institut fur systematik Botanik, Zurich) reported on the TAXONOMY OF TOXIC CYANOBACTERIA in Swiss alpine lakes. He used RAPD-PCR for the classification of 16 toxic and non-toxic strains of Microcystis aeruginosa. The toxicity of the strains had been checked by other groups in a mouse bioassay, with HPLC and in a phosphatase inhibition assay. A phylogenetic tree was derived from the RAPD data, but the toxic strains did not cluster together.

Andrea Nowotny (Institut fur pharm. Biologie, Greifswald) detected ANTIVIRAL ACTIVITY in aqueous extracts from Microcystis waterblooms in the south Baltic Sea. The nature of the substance that inhibits replication of influenza virus A could not be clarified.

Egbert Hoiczky (Max Planck Institut, Muenchen) related structural details of what may be the motor for GLIDING MOTILITY by cyanobacteria. Electron microscopical studies of the cell walls of strains from three different genera revealed that all species possess identical multilayered cell walls, which are covered with a complex double external layer, the surface of which is formed by a parallel array of helically arranged fibrils. The correlation of these structures with motion and their extracellular location indicates a possible role in gliding motility.

Alfred Hansel (Freiburg) presented his results concerning the major OUTER MEMBRANE PROTEINS of Synechococcus PCC 6301. After purification of the major outer membrane protein complex and its functional characterization, he cloned the gene coding for porin. Its sequence does not show any overall similarity with other porin sequences, but computer analysis indicates that the cyanobacterial porin has the same architecture as other porins. Downstream from this gene lay a second orf that shows great similarity (> 60%) to the porin gene, and reinvestigation of the protein led to the conclusion that Synechococcus has two different major outer membrane proteins, the monomers of which migrate almost identically in SDS gels. It is not yet clear if both function as porins.

-- Alfred Hansel



=====

**REFERENCES\*REFERENCES\*REFERENCES\*REFERENCES\*REFERENCES**

=====

**TAXONOMY and EVOLUTION**

- Bodas K, Brenning C, Diller KR, Brand JJ (1995). Cryopreservation of blue-green and eukaryotic algae in the culture collection at the University of Texas at Austin. *Cryo Lett* 16:267-274
- Cohen Z, Margheri MC, Tomaselli L (1995). Chemotaxonomy of cyanobacteria. *Phytochemistry* 40:1155-1158
- Hernandez-Marine MC, Canals T (1994). *Herpyzonema pulverulentum* (Mastigocladaceae), a new cavernicolous atmophytic and lime-incrusted cyanophyte. *Algal Studies* 75:123-136
- Merino V, Hernandez-Marine MC, Fernandez M (1994). Ultrastructure of *Mastigocladopsis repens* (Stigonematales, Cyanophyceae). *Cryptogam Algal* 15:37-46
- Romo S, Miracle MR, Hernandez-Marine MC (1993). *Geitlerinema amphibium* (Ag. ex Gom.) *Anagnostidis* (Cyanophyceae): morphology, ultrastructure and ecology. *Algal Studies* 69:11-27
- Romo S, Miracle MR, Hernandez-Marine MC (1993). Remarks on the morphology of *Pseudanabaena galeata* Boecher. *Algal Studies* 68:39-49
- Rott E, Hernandez-Marine MC (1994). *Pulvinularia suecica*, a rare stigonematalean cyanophyte. *Algal Studies* 75:313-322
- Kruse S, Martin W, Wehe M, Reski R (1995). An open reading frame (*ycf11*) is evolutionarily conserved from cyanobacteria to the plastid DNAs of archegoniates and gymnosperms, is modified in the plastid DNAs of dicots, and is not plastome-encoded in monocots. *J Plant Physiol* 146:258-262
- Loffelhardt W, Bohnert HJ (1994). Structure and function of the cyanelle genome. *Internat Rev Cytol* 151:29-65
- Nelissen B, Vandeppeer Y, Wilmotte A, Dewachter R (1995). An early origin of plastids within the cyanobacterial divergence is suggested by evolutionary trees based on complete 16S rRNA sequences. *Mol Biol Evol* 12:1166-1173
- Reith M (1995). Molecular biology of rhodophyte and chromophyte plastids. *Annu Rev Plant Physiol* 46:549-575

**ECOLOGY and SYMBIOSIS**

- Lorenz M, Boerner T, Hess WR (1995). Molecular cloning and characterization of a dihydrodipicolinate synthase (DHDPS) gene from the photoautotrophic prokaryote *Prochlorococcus marinus* CCMP 1375 (Prochlorophyta). *Endocyt Cell Res* 11:59-68
- Bebout BM, Garcia-Pichel F (1995). UV B-induced vertical migrations of cyanobacteria in a microbial mat. *Appl Environ Microbiol* 61:4215-4222

Budel B, Luttge U, Stelzer R, Huber O, Medina E (1995). Cyanobacteria of rocks and soils of the Orinoco lowlands and the Guayana Uplands, Venezuela. (vol 107, pg 422, 1994). *Bot Acta* 108:401 (Correction)

Carlton RG, Richardson LL (1995). Oxygen and sulfide dynamics in a horizontally migrating cyanobacterial mat: Black band disease of corals. *FEMS Microbiol Ecol* 18:155-162

Dewit R, van den Ende FP, van Gemerden H (1995). Mathematical simulation of the interactions among cyanobacteria, purple sulfur bacteria and chemotrophic sulfur bacteria in microbial mat communities. *FEMS Microbiol Ecol* 17:117-135

Epstein PR (1993). Algal blooms in the spread and persistence of cholera. *BioSystems* 31:209-221

Ernst A, Marschall P, Postius C (1995). Genetic diversity among *Synechococcus* spp. (cyanobacteria) isolated from the pelagial of Lake Constance. *FEMS Microbiol Ecol* 17:197-203

Garnham GW, Codd GA, Gadd GM (1995) Interaction of microalgae and cyanobacteria with toxic metals and radionuclides: physiology and environmental implications. In: Dyer KR, Orth RJ (eds) *Changes in Fluxes in Estuaries*. Olsen and Olsen, Fredensborg, Denmark, pp289-293

Hennes KP, Suttle CA, Chan AM (1995). Fluorescently labeled virus probes show that natural virus populations can control the structure of marine microbial communities. *Appl Environ Microbiol* 61:3623-3627

Howard A (1993). SCUM - simulation of cyanobacterial underwater movement. *Computer Applic Biosci* 9:413-419

Howard A (1995). Howard A et al (1995) Modelling the growth of cyanobacteria (GrowSCUM). *Hydrol Processes* 9:809-820

Howard A (1996). A review of cyanobacterial blooms in the UK and possible management strategies. *Prog Phys Geog* in press

Nold SC, Ward DM (1995). Diverse *Thermus* species inhabit a single hot spring microbial mat. *Syst Appl Microbiol* 18:274-278

Ortega-Calvo JJ, Arino X, Hernandez-Marine MC, Saiz-Jimenez C (1995). Factors affecting the weathering and colonization of monuments by phototrophic microorganisms. *Sci Total Environ* 167:329-341

Ortega-Calvo JJ, Hernandez-Marine M, Saiz-Jimenez C (1993) Cyanobacteria and algae on historic buildings and monuments. In: Garg KL, Garg N, Mukerji KG (eds) *Recent Advances in Biodeterioration and Biodegradation*, vol I. Naya Prokash, Calcutta

Ortega-Calvo JJ, Sanchez-Castillo PM, Hernandez-Marine MC, Saiz-Jimenez C (1993). Isolation and characterization of epilithic chlorophytes and cyanobacteria from two Spanish cathedrals (Salamanca and Toledo). *Nov Hedwig* 57:239-253

Stal LJ (1995). Physiological ecology of cyanobacteria in microbial mats and other communities. *New Phytol* 131:1-32

Taylor JA, Heaney SI, Codd GA (1995). Immunodetection of cyanobacterial picoplankton. *FEMS Microbiol Lett* 130:159-164

Toledo G, Bashan Y, Soeldner A (1995). Cyanobacteria and black mangroves in Northwestern Mexico: Colonization, and diurnal and seasonal nitrogen fixation on aerial roots. *Can J Microbiol* 41:999-1011

Wessels DCJ, Budel B (1995). Epilithic and cryptoendolithic cyanobacteria of Clarens sandstone cliffs in the Golden Gate Highlands National Park, South Africa. *Bot Acta* 108:220-226

Zehr JP, Mellon M, Braun S, Litaker W, Steppe T, Paerl HW (1995). Diversity of heterotrophic nitrogen fixation genes in a marine cyanobacterial mat. *Appl Environ Microbiol* 61:2527-2532

Zvyagintseva IS, Gerasimenko LM, Kostrikina NA, Bulygina ES, Zavarzin GA (1995). Interaction of halobacteria and cyanobacteria in a halophilic cyanobacterial community. *Microbiology-Engl Tr* 64:209-214

Ahern CP, Staff IA (1994). Symbiosis in cycads: The origin and development of coralloid roots in *Macrozamia communis* (Cycadaceae). *Am J Bot* 81:1559- 1570

Bilger W, Budel B, Mollenhauer R, Mollenhauer D (1994). Photosynthetic activity of two developmental stages of a *Nostoc* strain (cyanobacteria) isolated from *Geosiphon pyriforme* (Mycota). *J Phycol* 30:225-230

Gantar M, Kerby NW, Rowell P (1993). Colonization of wheat (*Triticum vulgare* L.) by N<sub>2</sub>-fixing cyanobacteria: III. The role of a hormogonia-promoting factor. *New Phytol* 124:505-513

Toledo G, Bashan Y, Soeldner A (1995). In vitro colonization and increase in nitrogen fixation of seedling roots of black mangrove inoculated by a filamentous cyanobacteria. *Can J Microbiol* 41:1012-1020

Vancoppenolle B, McCouch SR, Watanabe I, Huang N, Vanhove C (1995). Genetic diversity and phylogeny analysis of *Anabaena azollae* based on RFLPs detected in *Azolla-Anabaena azollae* DNA complexes using *nif* gene probes. *Theor Appl Genet* 91:589-597

## **TOXINS and NATURAL SUBSTANCES**

Bagchi SN (1995). Structure and site of action of an algicide from a cyanobacterium, *Oscillatoria late-virens*. *J Plant Physiol* 146:372-374

Bagy JR, Sonnichsen FD, Williams D, Andersen RJ, Sykes BD, Holmes CFB (1995). Comparison of the solution structures of microcystin-LR and motuporin. *Nature Struct Biol* 2:114-116

Bateman KP, Thibault P, Douglas DJ, White RL (1995). Mass spectral analyses of microcystins from toxic cyanobacteria using on-line chromatographic and electrophoretic separations. *J Chromatogr A* 712:253-268

Boyce RJ, Pattenden G (1995). Naturally occurring 4-methylthiazolines. A total synthesis of (-)-[4R, 4S]-didehydromirabazole A. *Tetrahedron* 51:7313- 7320

Clemens J, Oberer L, Quiquerez C, Konig WA, Weckesser J (1995). Cyanopeptolin S, a sulfate-containing depsipeptide from a water bloom of *Microcystis* sp. *FEMS Microbiol Lett* 129:129-133

Codd GA, Edwards C, Beattie KA, Lawton LA, Campbell DL, Bell SG (1995) Toxins from cyanobacteria (blue-green algae). In: Wiessner W, Schnepf E, Starr RC (eds) *Algae, Environment, and Human Affairs*. Biopress, Bristol, pp1- 17

Codd GA, Jefferies TM, Keevil CW, Potter E (eds) (1994) *Detection Methods for Cyanobacterial Toxins*. Royal Society of Chemistry, Cambridge

Codd GA, Steffensen DA, Burch MD, Baker PD (1994). Toxic blooms of cyanobacteria in Lake Alexandrina, South Australia -- learning from history. *Austral J Mar Fresh Res* 45:731-736

Edwards C, Annadotter H, Codd GA (1994) Cyanobacterial (blue-green algal) toxins in water bodies and supply sources: scientific advances and management needs. In: Stockholm Vatten (ed) *Proceedings of the Stockholm Water Symposium. Integrated Measures to Overcome Barriers to Minimizing Harmful Fluxes from Land to Water*. Stockholm Vatten, Stockholm, pp391- 400

Gmeiner P, Hummel E, Haubmann C (1995). Synthesis of optically active alpha,beta-disubstituted beta-amino nitriles and beta-amino acids starting from asparagine. *Liebigs Annalen:1987-1992*

Lawton LA, Edwards C, Beattie KA, Pleasance S, Dear GJ, Codd GA (1995). Isolation and characterization of microcystins from laboratory cultures and environmental samples of *Microcystis aeruginosa* and from an associated animal toxicosis. *Natural Toxins* 3:50-57

Matsunaga T, Takeyama H, Miura Y, Yamazaki T, Furuya H, Sode K (1995). Screening of marine cyanobacteria for high palmitoleic acid production. *FEMS Microbiol Lett* 133:137-141

Matsuura F, Hamada Y, Shioiri T (1995). Total synthesis of microginin, an angiotensin-converting enzyme inhibitory pentapeptide from the blue- green alga. *Tetrahedron* 51:12193 (Correction, 50:11303 (1994))

McDermott CM, Feola R, Plude J (1995). Detection of cyanobacterial toxins (microcystins) in waters of northeastern Wisconsin by a new immunoassay technique. *Toxicon* 33:1433-1442

Mierke DF, Rudolph-Bohner S, Muller G, Moroder L (1995). Structure of two microcystins: Refinement with nuclear overhauser effects and ensemble calculations. *Biopolymers* 36:811-828

Nagatsu A, Kajitani H, Sakakibara J (1995). Muscoride A: A new oxazole peptide alkaloid from freshwater cyanobacterium *Nostoc muscorum*. *Tetrahedron Lett* 36:4097-4100

Namikoshi M, Sun FR, Choi BW, Rinehart KL, Carmichael WW, Evans WR, Beasley VR (1995). Seven more microcystins from Homer Lake cells: Application of the general method for structure assignment of peptides containing alpha,beta-dehydroamino acid unit(s). *J Org Chem* 60:3671-3679

- Neilan BA, Jacobs D, Goodman AE (1995). Genetic diversity and phylogeny of toxic cyanobacteria determined by DNA polymorphisms within the phycocyanin locus. *Appl Environ Microbiol* 61:3875-3883
- Ojala J, Nagle DG, Hsu VL, Gerwick WH (1995). Antillatoxin: An exceptionally ichthyotoxic cyclic lipopeptide from the tropical cyanobacterium *Lyngbya majuscula*. *J Am Chem Soc* 117:8281-8282
- Okino T, Matsuda H, Murakami M, Yamaguchi K (1995). New microviridins, elastase inhibitors from the blue-green alga *Microcystis aeruginosa*. *Tetrahedron* 51:10679-10686
- Orjala J, Nagle D, Gerwick WH (1995). Malyngamide H, an ichthyotoxic amide possessing a new carbon skeleton from the Caribbean cyanobacterium *Lyngbya majuscula*. *J Nat Prod-Lloydia* 58:764-768
- Patterson GML, Bolis CM (1995). Regulation of scytonemin accumulation in cultures of *Scytonema ocellatum*. 2. Nutrient requirements. *Appl Microbiol Biotechnol* 43:692-700
- Prinsep MR, Patterson GML, Larsen LK, Smith CD (1995). Further tolyporphins from the blue-green alga *Tolypothrix nodosa*. *Tetrahedron* 51:10523-10530
- Rouhiainen L, Sivonen K, Buikema WJ, Haselkorn R (1995). Characterization of toxin-producing cyanobacteria by using an oligonucleotide probe containing a tandemly repeated heptamer. *J Bacteriol* 177:6021-6026
- Sano T, Kaya K (1995). Oscillamide Y, A chymotrypsin inhibitor from toxic *Oscillatoria agardhii*. *Tetrahedron Lett* 36:5933-5936
- Sano T, Kaya K (1995). A 2-amino-2-butenoic acid(Dhb)-containing microcystin isolated from *Oscillatoria agardhii*. *Tetrahedron Lett* 36:8603-8606
- Shin HJ, Murakami M, Matsuda H, Ishida K, Yamaguchi K (1995). Oscillapeptin, an elastase and chymotrypsin inhibitor from the cyanobacterium *Oscillatoria agardhii* (NIES-204). *Tetrahedron Lett* 36:5235-5238
- Todd JS, Gerwick WH (1995). Isolation of a cyclic carbonate, a gamma-butyrolactone, and a new indole derivative from the marine cyanobacterium *Lyngbya majuscula*. *J Nat Prod-Lloydia* 58:586-589
- Todd JS, Gerwick WH (1995). Malyngamide I from the tropical marine cyanobacterium *Lyngbya majuscula* and the probable structure revision of stylocheilamide. *Tetrahedron Lett* 36:7837-7840
- Valentekovich RJ, Schreiber SL (1995). Enantiospecific total synthesis of the protein phosphatase inhibitor motuporin. *J Am Chem Soc* 117:9069-9070

### **TOXINS and NATURAL SUBSTANCES (Physiological Effects)**

- Bell SG, Codd GA (1994). Cyanobacterial toxins and human health. *Rev Med Microbiol* 5:256-264
- Blankson H, Holen I, Seglen PO (1995). Disruption of the cytokeletin cytoskeleton and inhibition of hepatocytic autophagy by okadaic acid. *Exp Cell Res* 218:522-530

Blokhin AV, Yoo HD, Geraldts RS, Nagle DG, Gerwick WH, Hamel E (1995). Characterization of the interaction of the marine cyanobacterial natural product curacin A with the colchicine site of tubulin and initial structure-activity studies with analogues. *Mol Pharmacol* 48:523-531

Bury NR, Eddy FB, Codd GA (1995). The effects of the cyanobacterium *Microcystis aeruginosa*, the cyanobacterial hepatotoxin microcystin-LR, and ammonia on growth rate and ionic regulation of brown trout. *J Fish Biol* 46:1042-1054

Codd GA (1994) Blue-green algal toxins: water-borne hazards to health. In: Golding AMB, Noah N, Stanwell-Smith R (eds) *Water and Public Health*. Smith-Gordon, London, pp271-278

Delaney JM, Wilkins RM (1995). Toxicity of microcystin-LR, isolated from *Microcystis aeruginosa*, against various insect species. *Toxicon* 33:771- 778

Erdodi F, Toth B, Hirano K, Hirano M, Hartshorne DJ, Gergely P (1995). Endothall thioanhydride inhibits protein phosphatases-1 and -2A in vivo. *Amer J Physiol-Cell Physiol* 38:C1176-C1184

Falch BS, Konig GM, Wright AD, Sticher O, Angerhofer CK, Pezzuto JM, Bachmann H (1995). Biological activities of cyanobacteria: Evaluation of extracts and pure compounds. *Planta Med* 61:321-328

Goldberg J, Huang HB, Kwon YG, Greengard P, Nairn AC, Kuriyan J (1995). Three-dimensional structure of the catalytic subunit of protein serine/threonine phosphatase-1. *Nature* 376:745-753

Hartzell HC, Hirayama Y, Petitjacques J (1995). Effects of protein phosphatase and kinase inhibitors on the cardiac L-type Ca current suggest two sites are phosphorylated by protein kinase A and another protein kinase. *J Gen Physiol* 106:393-414

Kozikowski AP, Ma DW, Du L, Lewin NE, Blumberg PM (1995). Effect of alteration of the heterocyclic nucleus of ILV on its isoform selectivity for PKC. Palladium-catalyzed route to benzofuran analogues of ILV. *J Am Chem Soc* 117:6666-6672

Lahti K, Ahtiainen J, Rapala J, Sivonen K, Niemela SI (1995). Assessment of rapid bioassays for detecting cyanobacterial toxicity. *Lett Appl Microbiol* 21:109-114

Leclaire RD, Parker GW, Franz DR (1995). Hemodynamic and calorimetric changes induced by microcystin-LR in the rat. *J Appl Toxicol* 15:303-311

Mackintosh RW, Dalby KN, Campbell DG, Cohen PTW, Cohen P, Mackintosh C (1995). The cyanobacterial toxin microcystin binds covalently to cysteine-273 on protein phosphatase 1. *FEBS Lett* 371:236-240

Matsushimanishiwaki R, Shidoji Y, Nishiwaki S, Yamada T, Moriwaki H, Muto Y (1995). Suppression by carotenoids of microcystin-induced morphological changes in mouse hepatocytes. *Lipids* 30:1029-1034

Mooberry SL, Stratman K, Moore RE (1995). Tubercidin stabilizes microtubules against vinblastine-induced depolymerization, a taxol-like effect. *Cancer Lett* 96:261-266

Negri AP, Jones GJ (1995). Bioaccumulation of paralytic shellfish poisoning (PSP) toxins from the cyanobacterium *Anabaena circinalis* by the freshwater mussel *Alathyria condola*. *Toxicon* 33:667-678

Negri AP, Jones GJ, Hindmarsh M (1995). Sheep mortality associated with paralytic shellfish poisons from the cyanobacterium *Anabaena circinalis*. *Toxicon* 33:1321-1329

Rodger HD, Turnbull T, Edwards C, Codd GA (1994). Cyanobacterial (blue-green algal) bloom-associated pathology in brown trout (*Salmo trutta* L.) in Loch Leven, Scotland. *J Fish Dis* 17:177-181

Runnegar M, Berndt N, Kaplowitz N (1995). Microcystin uptake and inhibition of protein phosphatases: Effects of chemoprotectants and self-inhibition in relation to known hepatic transporters. *Toxicol Appl Pharmacol* 134:264-272

Runnegar M, Berndt N, Kong SM, Lee EYC, Zhang LF (1995). In vivo and in vitro binding of microcystin to protein phosphatases 1 and 2A. *Biochem Biophys Res Commun* 216:162-169

Sasaki M, Nakanuma Y, Watanabe K (1995). Hepatocellular prolapse of hepatic portal tracts and subendothelial space of central veins in idiopathic portal hypertension. *Histopathology* 27:67-70

Shimizu M, Iwasaki Y, Yamada S (1995). New fluorogenic dienophile: Synthesis, reaction with vitamin D, vitamin A and microcystins, and application to fluorometric assays. *Yakugaku Zasshi-J Pharm Soc J* 115:584-602

Sjoholm A, Honkanen RE, Berggren PO (1995). Inhibition of serine threonine protein phosphatases by secretagogues in insulin-secreting cells. *Endocrinology* 136:3391-3397

Spasova M, Mellor IR, Petrov AG, Beattie KA, Codd GA, Vais H, Usherwood PNR (1995). Pores formed in lipid bilayers and in native membranes by nodularin, a cyanobacterial toxin. *Eur Biophys J* 24:69-76

Szoor B, Feher Z, Bako E, Erdodi F, Szabo G, Gergely P, Dombradi V (1995). Isolation and characterization of the catalytic subunit of protein phosphatase 2A from *Neurospora crassa*. *Comp Biochem Physiol [B]* 112:515- 522

Takai A, Sasaki K, Nagai H, Mieskes G, Isobe M, Isono K, Yasumoto T (1995). Inhibition of specific binding of okadaic acid to protein phosphatase 2A by microcystin-LR, calyculin-A and tautomycin: Method of analysis of interactions of tight-binding ligands with target proteins (vol 306, pg 657, 1995). *Biochem J* 308:1039

Wickstrom ML, Khan SA, Haschek WM, Wyman JF, Eriksson JE, Schaeffer DJ, Beasley VR (1995). Alterations in microtubules, intermediate filaments, and microfilaments induced by microcystin-LR in cultured cells. *Toxicol Pathol* 23:326-337

Yu SZ (1995). Primary prevention of hepatocellular carcinoma. *J Gastroenterol Hepatol* 10:674-682 (microcystin as a carcinogen)

## PHYSIOLOGY

- Arino X, Ortega-Calvo JJ, Hernandez-Marine M, Saiz-Jimenez C (1995). Effect of sulfur starvation on the morphology and ultrastructure of the cyanobacterium *Gloeothoece* sp PCC 6909. *Arch Microbiol* 163:447-453
- Bartsevich VV, Shestakov SV (1995). The *dspA* gene product of the cyanobacterium *Synechocystis* sp strain PCC 6803 influences sensitivity to chemically different growth inhibitors and has amino acid similarity to histidine protein kinases. *Microbiology Uk* 141(Part 11):2915-2920
- Gilpin C, Sigee DC (1995). X-ray microanalysis of wet biological specimens in the environmental scanning electron microscope. 1. Reduction of specimen distance under different atmospheric conditions. *J Microsc-Oxford* 179(Part 1):22-28 (Anabaena)
- Hayes PK, Powell RS (1995). The *gvpA/C* cluster of *Anabaena flos-aquae* has multiple copies of a gene encoding GvpA. *Arch Microbiol* 164:50-57
- Katayama M, Wada Y, Ohmori M (1995). Molecular cloning of the cyanobacterial adenylate cyclase gene from the filamentous cyanobacterium *Anabaena cylindrica*. *J Bacteriol* 177:3873-3878
- Katayama M, Wada Y, Ohmori M (1995). Molecular cloning of the cyanobacterial adenylate cyclase gene from the filamentous cyanobacterium *Anabaena cylindrica* (vol 177, pg 3875, 1995). *J Bacteriol* 177:5197 (Correction)
- Kinsman R, Walsby AE, Hayes PK (1995). GvpCs with reduced numbers of repeating sequence elements bind to and strengthen cyanobacterial gas vesicles. *Mol Microbiol* 17:147-154
- Nicholson ML, Gaasenbeek M, Laudenbach DE (1995). Two enzymes together capable of cysteine biosynthesis are encoded on a cyanobacterial plasmid. *Mol Gen Genet* 247:623-632
- Pitta TP, Berg HC (1995). Self-electrophoresis is not the mechanism for motility in swimming cyanobacteria. *J Bacteriol* 177:5701-5703
- Wagner F, Falkner R, Falkner G (1995). Information about previous phosphate fluctuations is stored via an adaptive response of the high-affinity phosphate uptake system of the cyanobacterium *Anacystis nidulans*. *Planta* 197:147-155
- Aoki S, Kondo T, Ishiura M (1995). Circadian expression of the *dnaK* gene in the cyanobacterium *Synechocystis* sp strain PCC 6803. *J Bacteriol* 177:5606-5611
- Liu Y, Tsinoremas NF, Johnson CH, Lebedeva NV, Golden SS, Ishiura M, Kondo T (1995). Circadian orchestration of gene expression in cyanobacteria. *Gene Develop* 9:1469-1478

## STRESS RESPONSES

- Fulda S, Hagemann M (1995). Salt treatment induces accumulation of flavodoxin in the cyanobacterium *Synechocystis* sp PCC 6803. *J Plant Physiol* 146:520-526
- Iwano M (1995). Selective effect of salt stress on the activity of two ATPases in the cell membrane of *Nostoc muscorum*. *Plant Cell Physiol* 36:1297-1301

- Schoor A, Erdmann N, Effmert U, Mikkat S (1995). Determination of the cyanobacterial osmolyte glucosylglycerol by high-performance liquid chromatography. *J Chromatogr A* 704:89-97
- Yano S, Kawata Y, Kojima H (1995). Salinity-dependent copy number change of endogenous plasmids in *Synechococcus* sp strain PCC 7002. *Curr Microbiol* 31:357-360
- Erbe JL, Taylor KB, Hall LM (1995). Metalloregulation of the cyanobacterial *smt* locus: Identification of *SmtB* binding sites and direct interaction with metals. *Nucleic Acids Res* 23:2472-2478
- Hammouda O, Borbely G (1995). Alterations in protein synthesis in the cyanobacterium *Synechococcus* sp strain PCC 6301 in response to *Calendula micrantha* extract with molluscicidal activity. *Ecotoxicol Environ Safety* 31:201-204
- Karamushka VI, Gruzina TG, Ulberg ZR (1995). Accumulation of gold(III) by the cells of cyanobacterium *Spirulina platensis*. *Microbiology-Engl Tr* 64:157-160
- Khassanova Q, Collery P, Etienne JC, Khassanova Z, Yangurazova Z (1994) The Influence of Copper Ions on the Photosynthetic Activity of the Cyanobacterium *Synechocystis aquatilis*. In: Collery P, Poirier LA, Littlefield NA, Etienne JC (eds) *Metal Ions in Biology and Medicine*, vol Vol 3. Publisher: John Libbey Eurotext Ltd, Montrouge, France, pp181-185
- Pena MMO, Bullerjahn GS (1995). The DpsA protein of *Synechococcus* sp strain PCC 7942 is a DNA-binding hemoprotein - Linkage of the Dps and bacterioferritin protein families. *J Biol Chem* 270:22478-22482
- Turner JS, Robinson NJ (1995). Cyanobacterial metallothioneins: Biochemistry and molecular genetics. *J Ind Microbiol* 14:119-125

## **NITROGEN METABOLISM**

- Jackman DM, Mulligan ME (1995). Characterization of a nitrogen-fixation (*nif*) gene cluster from *Anabaena azollae* 1a shows that closely related cyanobacteria have highly variable but structured intergenic regions. *Microbiol UK* 141:2235-2244
- Reimels AJ, Reddy KJ (1995). Analysis of *Cyanothece* sp BH68K mutants defective in aerobic nitrogen fixation. *Curr Microbiol* 31:174-179
- Schrautemeier B, Neveling U, Schmitz S (1995). Distinct and differently regulated Mo-dependent nitrogen-fixing systems evolved for heterocysts and vegetative cells of *Anabaena variabilis* ATCC 29413: Characterization of the *fdxH1/2* gene regions as part of the *nif1/2* gene clusters. *Mol Microbiol* 18:357-369
- Thiel T, Lyons EM, Erker JC, Ernst A (1995). A second nitrogenase in vegetative cells of a heterocyst-forming cyanobacterium. *Proc Natl Acad Sci USA* 92:9358-9362
- Yakunin AF, Troshina OY, Gogotov IN (1995). Relationship between nitrogenase synthesis and the C/N ratio in the nitrogen-fixing cyanobacterium *Anabaena variabilis*. *Microbiology-Engl Tr* 64:5-6

Chavez S, Reyes JC, Chauvat F, Florencio FJ, Candau P (1995). The NADP-glutamate dehydrogenase of the cyanobacterium *Synechocystis* 6803: Cloning, transcriptional analysis and disruption of the *gdhA* gene. *Plant Mol Biol* 28:173-188

Forchhammer K, Demarsac NT (1995). Phosphorylation of the PII protein (glnB gene product) in the cyanobacterium *Synechococcus* sp. strain PCC 7942: Analysis of in vitro kinase activity. *J Bacteriol* 177:5812-5817

Fredriksson C, Bergman B (1995). Nitrogenase quantity varies diurnally in a subset of cells within colonies of the nonheterocystous cyanobacteria *Trichodesmium* spp. *Microbiology Uk* 141:2471-2478

Merchan F, Kindle KL, Llama MJ, Serra JL, Fernandez E (1995). Cloning and sequencing of the nitrate transport system from the thermophilic, filamentous cyanobacterium *Phormidium laminosum*: Comparative analysis with the homologous system from *Synechococcus* sp PCC 7942. *Plant Mol Biol* 28:759-766

Pandey PK, Singh BB, Singh S, Bisen PS (1995). NO<sub>2</sub>- efflux and its regulation in cyanobacterium *Nostoc* MAC. *Curr Microbiol* 31:119-123

Reyes JC, Crespo JL, Garcia-Dominguez M, Florencio FJ (1995). Electron transport controls glutamine synthetase activity in the facultative heterotrophic cyanobacterium *Synechocystis* sp PCC 6803. *Plant Physiol* 109:899-905

Reyes JC, Florencio FJ (1995). A novel mechanism of glutamine synthetase inactivation by ammonium in the cyanobacterium *Synechocystis* sp PCC 6803. Involvement of an inactivating protein. *FEBS Lett* 367:45-48

Sanz AP, Moreno-Vivian C, Maldonado JM, Gonzalez-Fontes A (1995). Effect of a constant supply of different nitrogen sources on protein and carbohydrate content and enzyme activities of *Anabaena variabilis* cells. *Physiol Plant* 95:39-44

Silman NJ, Carr NG, Mann NH (1995). ADP-ribosylation of glutamine synthetase in the cyanobacterium *Synechocystis* sp strain PCC 6803. *J Bacteriol* 177:3527-3533

Suzuki I, Kikuchi H, Nakanishi S, Fujita Y, Sugiyama T, Omata T (1995). A novel nitrite reductase gene from the cyanobacterium *Plectonema boryanum*. *J Bacteriol* 177:6137-6143

Tapia MI, Llama MJ, Serra JL (1995). Active glutamine synthetase is required for ammonium- or glutamine-promoted prevention of nitrate and nitrite reduction in the cyanobacterium *Phormidium laminosum*. *Physiol Plant* 94:241-246

Zinovieva M, Fresneau C, Arrio B (1995). Contribution of nitrate to H<sup>+</sup> permeability of *Synechococcus* PCC 6311 plasmalemma vesicles. *Biochim Biophys Acta* 1230:91-96

### **HETEROCYST and AKINETE DIFFERENTIATION**

Black K, Buikema WJ, Haselkorn R (1995). The *hglK* gene is required for localization of heterocyst-specific glycolipids in the cyanobacterium *Anabaena* sp strain PCC 7120. *J Bacteriol* 177:6440-6448

Carrasco CD, Golden JW (1995). Two heterocyst-specific DNA rearrangements of nif operons in *Anabaena cylindrica* and *Nostoc* sp Strain Mac. *Microbiology Uk* 141:2479-2487

Hardin SC, Fisher RW (1995). Characterization of akinete differentiation in the cyanobacterium *Anabaena azollae*. *Curr Microbiol* 31:265-269

### **CARBON METABOLISM**

Bainbridge G, Madgwick P, Parmar S, Mitchell R, Paul M, Pitts J, Keys AJ, Parry MAJ (1995). Engineering Rubisco to change its catalytic properties. *J Exp Bot* 46:1269-1276

Newman J, Karakaya H, Scanlan DJ, Mann NH (1995). A comparison of gene organization in the *zwf* region of the genomes of the cyanobacteria *Synechococcus* sp PCC 7942 and *Anabaena* sp PCC 7120. *FEMS Microbiol Lett* 133:187-193

Pacold ME, Stevens FJ, Li D, Anderson LE (1995). The NADP-linked glyceraldehyde-3-phosphate dehydrogenases of *Anabaena variabilis* and *Synechocystis* PCC 6803, which lack one of the cysteines found in the higher plant enzyme, are not reductively activated. *Photosynth Res* 43:125-130

Ronentarazi M, Lieman-Hurwitz J, Gabay C, Orus MI, Kaplan A (1995). The genomic region of *rbclS* in *Synechococcus* sp PCC 7942 contains genes involved in the ability to grow under low CO<sub>2</sub> concentration and in chlorophyll biosynthesis. *Plant Physiol* 108:1461-1469

Summers ML, Wallis JG, Campbell EL, Meeks JC (1995). Genetic evidence of a major role for glucose-6-phosphate dehydrogenase in nitrogen fixation and dark growth of the cyanobacterium *Nostoc* sp strain ATCC 29133. *J Bacteriol* 177:6184-6194

Wadano A, Kamata Y, Iwaki T, Nishikawa K, Hirahashi T (1995). Purification and characterization of phosphoribulokinase from the cyanobacterium *Synechococcus* PCC 7942. *Plant Cell Physiol* 36:1381-1385

### **HYDROGEN METABOLISM**

Mikheeva LE, Schmitz O, Shestakov SV, Bothe H (1995). Mutants of the cyanobacterium *Anabaena variabilis* altered in hydrogenase activities. *Z Naturforsch C* 50:505-510

Schmitz O, Boison G, Hilscher R, Hundeshagen B, Zimmer W, Lottspeich F, Bothe H (1995). Molecular biological analysis of a bidirectional hydrogenase from cyanobacteria. *Eur J Biochem* 233:266-276

Serebriakova LT, Troshina OY, Gogotov IN (1995). Purification and forms of reversible hydrogenase from *Anabaena variabilis* ATCC 29413. *Biochemistry-Engl Tr* 60:373-377

Serebryakova LT, Gogotov IN (1995). Catalytic properties of the reversible hydrogenase from *Anabaena variabilis* ATCC 29413. *Biochemistry-Engl Tr* 60:781-785

Tamagnini P, Oxelfelt F, Salema R, Lindblad P (1995). Immunological characterization of hydrogenases in the nitrogen-fixing cyanobacterium *Nostoc* sp strain PCC 73102. *Curr Microbiol* 31:102-107

## **MEMBRANES**

Gambacorta A, Soriente A, Trincone A, Sodano G (1995). Biosynthesis of the heterocyst glycolipids in the cyanobacterium *Anabaena cylindrica*. *Phytochemistry* 39:771-774

Garozzo D, Impallomeni G, Spina E, Sturiale L, Cesaro A, Cescutti P (1995). Identification of N-acetylglucosamine and 4-O-[1-carboxyethyl]mannose in the exopolysaccharide from *Cyanospira capsulata*. *Carbohydr Res* 270:97-106

Kashiwagi S, Kanamaru K, Mizuno T (1995). A *Synechococcus* gene encoding a putative pore-forming intrinsic membrane protein. *Biochim Biophys Acta* 1237:189-192

Moon BY, Higashi SI, Gombos Z, Murata N (1995). Unsaturation of the membrane lipids of chloroplasts stabilizes the photosynthetic machinery against low-temperature photoinhibition in transgenic tobacco plants. *Proc Natl Acad Sci USA* 92:6219-6223

Somerville C (1995). Direct tests of the role of membrane lipid composition in low-temperature-induced photoinhibition and chilling sensitivity in plants and cyanobacteria. *Proc Natl Acad Sci USA* 92:6215-6218

Zinovieva M, Fresneau C, Arrio B (1995). Effect of salts on the electrophoretic mobility of *Synechococcus* PCC 7942 plasmalemma vesicles from cells grown on different nitrogen sources. *Bioelectrochem Bioenerg* 38:169-171

## **PHOTOSYNTHESIS and PHOTOSYSTEMS**

Koenig F, Schmidt M (1995). *Gloeobacter violaceus* - Investigation of an unusual photosynthetic apparatus. Absence of the long wavelength emission of photosystem I in 77 K fluorescence spectra. *Physiol Plant* 94:621-628

Meunier PC, Burnap RL, Sherman LA (1995). Interaction of the photosynthetic and respiratory electron transport chains producing slow O<sub>2</sub> signals under flashing light in *Synechocystis* sp PCC 6803. *Photosynth Res* 45:31- 40

Murthy SDS, Mohanty N, Mohanty P (1995). Prolonged incubation with low concentrations of mercury alters energy transfer and chlorophyll (Chl) a protein complexes in *Synechococcus* 6301: Changes in Chl a absorption and emission characteristics and loss of the F695 emission band. *Biometals* 8:237-242

Schreiber U, Endo T, Mi HL, Asada K (1995). Quenching analysis of chlorophyll fluorescence by the saturation pulse method: Particular aspects relating to the study of eukaryotic algae and cyanobacteria. *Plant Cell Physiol* 36:873-882

Singh DP, Verma K (1995). Response of the wild-type and high light-tolerant mutant of *Anacystis nidulans* against photooxidative damage: Differential mechanism of high light tolerance. *Photochem Photobiol* 62:314-319

Webber AN, Bingham SE, Lee H (1995). Genetic engineering of thylakoid protein complexes by chloroplast transformation in *Chlamydomonas reinhardtii*. *Photosynth Res* 44:191-205

Chitnis PR, Xu Q, Chitnis VP, Nechushtai R (1995). Function and organization of Photosystem I polypeptides. *Photosynth Res* 44:23-40

Cohen Y, Nelson N, Chitnis PR, Nechushtai R (1995). The carboxyl-terminal region of the spinach PsaD subunit contains information for its specific assembly into plant thylakoids. *Photosynth Res* 44:157-164

Lee JW, Lee I, Laible PD, Owens TG, Greenbaum E (1995). Chemical platinization and its effect on excitation transfer dynamics and P700 photooxidation kinetics in isolated photosystem I. *Biophys J* 69:652-659

Mamedov MD, Gadzhieva RM, Drachev LA, Zaspaa AA, Semenov AY (1995). Generation of electric potential in proteoliposomes containing PS1 complexes from cyanobacteria. *Biochemistry-Engl Tr* 60:565-568

Motoki A, Shimazu T, Hirano M, Katoh S (1995). The two psbA genes from the thermophilic cyanobacterium *Synechococcus elongatus*. *Plant Physiol* 108:1305-1306

Naver H, Scott MP, Andersen B, Moller BL, Scheller HV (1995). Reconstitution of barley photosystem I reveals that the N-terminus of the PSI-D subunit is essential for tight binding of PSI-C. *Physiol Plant* 95:19-26

Setif PQY, Bottin H (1995). Laser flash absorption spectroscopy study of ferredoxin reduction by photosystem I: Spectral and kinetic evidence for the existence of several photosystem I-ferredoxin complexes. *Biochemistry* 34:9059-9070

Shen GZ, Bryant DA (1995). Characterization of a *Synechococcus* sp strain PCC 7002 mutant lacking Photosystem I. Protein assembly and energy distribution in the absence of the Photosystem I reaction center core complex. *Photosynth Res* 44:41-53

Tsiotis G, Haase W, Engel A, Michel H (1995). Isolation and structural characterization of trimeric cyanobacterial photosystem I complex with the help of recombinant antibody fragments. *Eur J Biochem* 231:823-830

Xu Q, Chitnis PR (1995). Organization of photosystem I polypeptides - Identification of PsaB domains that may interact with PsaD. *Plant Physiol* 108:1067-1075

Xu Q, Hoppe D, Chitnis VP, Odom WR, Guikema JA, Chitnis PR (1995). Mutational analysis of photosystem I polypeptides in the cyanobacterium *Synechocystis* sp, PCC 6803 - Targeted inactivation of psal reveals the function of PsaI in the structural organization of PsaL. *J Biol Chem* 270:16243-16250

Yu JP, Smart LB, Jung YS, Golbeck J, McIntosh L (1995). Absence of PsaC subunit allows assembly of photosystem I core but prevents the binding of PsaD and PsaE in *Synechocystis* sp PCC 6803. *Plant Mol Biol* 29:331-342

Arellano JB, Lazaro JJ, Lopez-Gorge J, Baron M (1995). The donor side of Photosystem II as the copper-inhibitory binding site - Fluorescence and polarographic studies. *Photosynth Res* 45:127-134

Campbell D, Zhou GQ, Gustafsson P, Oquist G, Clarke AK (1995). Electron transport regulates exchange of two forms of photosystem II D1 protein in the cyanobacterium *Synechococcus*. *Embo J* 14:5457-5466

Clarke AK, Campbell D, Gustafsson P, Oquist G (1995). Dynamic responses of photosystem II and phycobilisomes to changing light in the cyanobacterium *Synechococcus* sp PCC 7942. *Planta* 197:553-562

Falk S, Samson G, Bruce D, Huner NPA, Laudenbach DE (1995). Functional analysis of the iron-stress induced CP 43' polypeptide of PS II in the cyanobacterium *Synechococcus* sp PCC 7942. *Photosynth Res* 45:51-60

Hillmann B, Schlodder E (1995). Electron transfer reactions in Photosystem II core complexes from *Synechococcus* at low temperature -Difference spectrum of P680+ QA-/P680 QA at 77 K. *Biochim Biophys Acta* 1231:76-88

Irrgang KD, Shi LX, Funk C, Schroder WP (1995). A nuclear-encoded subunit of the photosystem II reaction center. *J Biol Chem* 270:17588-17593

Kless H, Vermaas W (1995). Tandem sequence duplications functionally complement deletions in the D1 protein of photosystem II. *J Biol Chem* 270:16536-16541

Komenda J, Barber J (1995). Comparison of psbO and psbH deletion mutants of *Synechocystis* PCC 6803 indicates that degradation of D1 protein is regulated by the QB site and dependent on protein synthesis. *Biochemistry* 34:9625-9631

Komenda J, Masojidek J (1995). Functional and structural changes of the photosystem II complex induced by high irradiance in cyanobacterial cells. *Eur J Biochem* 233:677-682

Kruse O, Schmid GH (1995). The role of phosphatidylglycerol as a functional effector and membrane anchor of the D1-core peptide from photosystem II particles of the cyanobacterium *Oscillatoria chalybea*. *Z Naturforsch C* 50:380-390

Maenpaa P, Miranda T, Tyystjarvi E, Tyystjarvi T, Govindjee, Ducruet JM, Etienne AL, Kirilovsky D (1995). A mutation in the D-de loop of D-1 modifies the stability of the S2QA- and S2QB- states in photosystem II. *Plant Physiol* 107:187-197

Sato K, Ohhashi M, Kashino Y, Koike H (1995). Mechanism of electron flow through the QB site in photosystem II. 1. Kinetics of the reduction of electron acceptors at the QB and plastoquinone sites in photosystem II particles from the cyanobacterium *Synechococcus vulcanus*. *Plant Cell Physiol* 36:597-605

Setlikova E, Ritter S, Hienerwadel R, Kopecky J, Komenda J, Welte W, Setlik I (1995). Purification of a Photosystem II reaction center from a thermophilic cyanobacterium using immobilized metal affinity chromatography. *Photosynth Res* 43:201-211

Shen JR, Burnap RL, Inoue Y (1995). An independent role of cytochrome c-550 in cyanobacterial photosystem II as revealed by double-deletion mutagenesis of the psbO and psbV genes in *Synechocystis* sp PCC 6803. *Biochemistry* 34:12661-12668

Vermaas W, Madsen C, Yu JJ, Visser J, Metz J, Nixon PJ, Diner B (1995). Turnover of the D1 protein and of Photosystem II in a *Synechocystis* 6803 mutant lacking Tyr(z). *Photosynth Res* 45:99-104

### **PHYCOBILISOMES and OTHER PIGMENTS**

Ajlani G, Vernotte C, Dimagno L, Haselkorn R (1995). Phycobilisome core mutants of *Synechocystis* PCC 6803. *Biochim Biophys Acta* 1231:189-196

Anderson L, Plank T, Toole C, Cai JF (1995). Subunit interactions, chromophore attachment, and proteolysis in the assembly of cyanobacterial light-harvesting proteins. *Protein Eng* 8(Suppl.):17

Bhalerao RP, Gillbro T, Gustafsson F (1995). Functional phycobilisome core structures in a phycocyanin-less mutant of cyanobacterium *Synechococcus* sp PCC 7942. *Photosynth Res* 45:61-70

Demidov AA, Mimuro M (1995). Deconvolution of C-phycocyanin beta-84 and beta-155 chromophore absorption and fluorescence spectra of cyanobacterium *Mastigocladus laminosus*. *Biophys J* 68:1500-1506

Hoff WD, Matthijs HCP, Schubert H, Crielaard W, Hellingwerf KJ (1995). Rhodopsin(s) in eubacteria. *Biophys Chem* 56:193-199

Maccoll R, Malak H, Cipollo J, Label B, Ricci G, Maccoll D, Leslie LE (1995). Studies on the dissociation of cryptomonad biliproteins. *J Biol Chem* 270:27555-27561

Plank T, Anderson LK (1995). Heterologous assembly and rescue of stranded phycocyanin subunits by expression of a foreign *cpcBA* operon in *Synechocystis* sp strain 6803. *J Bacteriol* 177:6804-6809

Plank T, Toole C, Anderson LK (1995). Subunit interactions and protein stability in the cyanobacterial light-harvesting proteins. *J Bacteriol* 177:6798-6803

Schneider S, Prenzel CJ, Brehm G, Gottschalk L, Zhao KH, Scheer H (1995). Resonance-enhanced CARS spectroscopy of biliproteins. Influence of aggregation and linker proteins on chromophore structure in allophycocyanin (*Mastigocladus laminosus*). *Photochem Photobiol* 62:847-854

Westermann M, Wehrmeyer W (1995). A new type of complementary chromatic adaptation exemplified by *Phormidium* sp C86: Changes in the number of peripheral rods and in the stoichiometry of core complexes in phycobilisomes. *Arch Microbiol* 164:132-141

Beale SI (1994) Biosynthesis of open-chain tetrapyrroles in plants, algae, and cyanobacteria. In: Chadwick DJ, Ackrill K (eds) *Biosynthesis of the Tetrapyrrole Pigments*, vol 180. John Wiley & Sons Ltd, Baffins Lane, United Kingdom, pp156-168

Fujita Y, Murakami A, Aizawa K (1995). The accumulation of protochlorophyllide in cells of *Synechocystis* PCC 6714 with a low PSI-PSII stoichiometry. *Plant Cell Physiol* 36:575-582

Kannangara CG, Andersen RV, Pontoppidan B, Willows R, Vonwettstein D (1994) Enzymic and mechanistic studies on the conversion of glutamate to

5-aminolaevulinate. In: Chadwick DJ, Ackrill K (eds) Biosynthesis of the Tetrapyrrole Pigments, vol 180. John Wiley & Sons Ltd, Baffins Lane, United Kingdom, pp3-20  
Paulsen H (1995). Chlorophyll a/b-binding proteins. *Photochem Photobiol* 62:367-382

Tyacke RJ, Contestabile R, Grimm B, Harwood JL, John RA (1995). Reactions of glutamate semialdehyde aminotransferase (glutamate-1-semialdehyde 2,1 aminomutase) with vinyl and acetylenic substrate analogues analysed by rapid scanning spectrophotometry. *Biochem J* 309:307-313

Tyagi R, Saxena S, Kaushik BD (1995). Induction and characterization of UV resistant *Calothrix braunii*. *J Plant Biochem Biotechnol* 4:127-129

#### ELECTRON TRANSPORT and BIOENERGETICS

Auer G, Mayer B, Wastyn M, Fromwald S, Eghbalzad K, Alge D, Peschek GA (1995). Promiscuity of heme groups in the cyanobacterial cytochrome-c oxidase. *Biochem Mol Biol Internatl* 37:1173-1185

Dworsky A, Mayer B, Regelsberger G, Fromwald S, Peschek GA (1995). Functional and immunological characterization of both "mitochondria-like" and "chloroplast-like" electron/proton transport proteins in isolated and purified cyanobacterial membranes. *Bioelectrochem Bioenerg* 38:35-43

Friedrich T, Steinmuller K, Weiss H (1995). The proton-pumping respiratory complex I of bacteria and mitochondria and its homologue in chloroplasts. *FEBS Lett* 367:107-111

Gu TQ, Iwama Y, Murakami A, Adhikary SP, Fujita Y (1994). Changes in the cytochrome c oxidase activity in response to light regime for photosynthesis observed with the cyanophyte *Synechocystis* PCC 6714. *Plant Cell Physiol* 35:1135-1140

Hervas M, Navarro JA, Diaz A, Bottin H, Delarosa MA (1995). Laser-flash kinetic analysis of the fast electron transfer from plastocyanin and cytochrome c6 to photosystem I. Experimental evidence on the evolution of the reaction mechanism. *Biochemistry* 34:11321-11326

Mi HL, Endo T, Ogawa T, Asada K (1995). Thylakoid membrane-bound, NADPH-specific pyridine nucleotide dehydrogenase complex mediates cyclic electron transport in the cyanobacterium *Synechocystis* sp PCC 68038. *Plant Cell Physiol* 36:661-668

Ohki K, Fujita Y (1995). Intracellular location of cytochrome oxidase active in vivo in the cyanophytes, *Synechocystis* sp PCC 6714 and *Anacystis nidulans* Tx20 and R2, grown under various conditions. *Protoplasma* 188:70-77

Peschek GA, Alge D, Fromwald S, Mayer B (1995). Transient accumulation of heme O (cytochrome o) in the cytoplasmic membrane of semi-anaerobic *Anacystis nidulans* - Evidence for oxygenase-catalyzed heme O/A transformation. *J Biol Chem* 270:27937-27941

Peschek GA, Wastyn M, Fromwald S, Mayer B (1995). Occurrence of heme O in photoheterotrophically growing, semi-anaerobic cyanobacterium *Synechocystis* sp. PCC 6803. *FEBS Lett* 371:89-93

Bes MT, Delacey AL, Fernandez VM, Gomez-Moreno C (1995). Electron transfer between viologen derivatives and the flavoprotein ferredoxin-NADP<sup>+</sup> reductase. *Bioelectrochem Bioenerg* 38:179-184

Bes MT, Delacey AL, Peleato ML, Fernandez VM, Gomez-Moreno C (1995). The covalent linkage of a viologen to a flavoprotein reductase transforms it into an oxidase. *Eur J Biochem* 233:593-599

Bes MT, Razquin P, Gomez-Moreno C (1995). Interference of nucleases in cyanobacterium ferredoxin purification. *Prep Biochem* 25:89-97

Burkhart BM, Ramakrishnan B, Yan H, Reedstrom RJ, Markley JL, Straus NA, Sundaralingam M (1995). Structure of the trigonal form of recombinant oxidized flavodoxin from *Anabaena* 7120 at 1.40 Å resolution. *Acta Crystallogr D-Biol Cryst* 51(Part 3):318-330

Hirasawa M, Kleissanfrancisco S, Proske PA, Knaff DB (1995). The effect of N-bromosuccinimide on ferredoxin:NADP(+) oxidoreductase. *Arch Biochem Biophys* 320:280-288

Hurley JK, Fillat M, Gomez-Moreno C, Tollin G (1995). Structure-function relationships in the ferredoxin/ferredoxin:NADP<sup>+</sup> reductase system from *Anabaena*. *Biochimie* 77:539-548

Jiang FY, Hellman U, Sroga GE, Bergman B, Mannervik B (1995). Cloning, sequencing, and regulation of the glutathione reductase gene from the cyanobacterium *Anabaena* PCC 7120. *J Biol Chem* 270:22882-22889

Lelong C, Setif P, Bottin H, Andre F, Neumann JM (1995). <sup>1</sup>H and <sup>15</sup>N NMR sequential assignment, secondary structure, and tertiary fold of [2Fe- 2S] ferredoxin from *Synechocystis* sp PCC 6803. *Biochemistry* 34:14462- 14473

Navarro JA, Hervas M, Genzor CG, Cheddar G, Fillat MF, Delarosa MA, Gomez-Moreno C, Cheng H, Xia B, Chae YK, Yan H, Wong B, Straus NA, Markley JL, Hurley JK, Tollin G (1995). Site-specific mutagenesis demonstrates that the structural requirements for efficient electron transfer in *Anabaena* ferredoxin and flavodoxin are highly dependent on the reaction partner: Kinetic studies with photosystem I, ferredoxin:NADP<sup>+</sup> reductase, and cytochrome c. *Arch Biochem Biophys* 321:229-238

Razquin P, Fillat MF, Gomez-Moreno C, Peleato ML (1995). The 36 kDa form of ferredoxin-NADP<sup>+</sup> reductase from *Anabaena* co-purifies with phycobiliproteins. *Bioelectrochem Bioenerg* 38:57-61

Saarinen M, Gleason FK, Eklund H (1995). Crystal structure of thioredoxin-2 from *Anabaena*. *Structure* 3:1097-1108

Schmitz S, Bohme H (1995). Amino acid residues involved in functional interaction of vegetative cell ferredoxin from the cyanobacterium *Anabaena* sp. PCC 7120 with

ferredoxin:NADP reductase, nitrite reductase and nitrate reductase. *Biochim Biophys Acta* 1231:335-341

Vidakovic M, Fraczkiewicz G, Dave BC, Czernuszewicz RS, Germanas JP (1995). The environment of [2Fe-2S] clusters in ferredoxins: The role of residue 45 probed by site-directed mutagenesis. *Biochemistry* 34:13906-13913

Sigalat C, Pitard B, Haraux F (1995). Proton coupling is preserved in membrane-bound chloroplast ATPase activated by high concentrations of tentoxin. *FEBS Lett* 368:253-256

Steinemann D, Lill H (1995). Sequence of the gamma-subunit of *Spirulina platensis*: A new principle of thiol modulation of F<sub>0</sub>F<sub>1</sub> ATP synthase? *Biochim Biophys Acta* 1230:86-90

## **MOLECULAR GENETICS, EPISOMES, AND METABOLISM OF MACROMOLECULES**

Haselkorn R (1995). (Review) *The Molecular Biology of Cyanobacteria*, by D.A. Bryant. *Science* 269:1121

Ramasubramanian TS, Pu F, Golden JW (1995). Isolation of the *Anabaena* sp strain PCC 7120 sigA gene in a transcriptional-interference selection. *J Bacteriol* 177:6676-6678

Sato N (1995). A family of cold-regulated RNA-binding protein genes in the cyanobacterium *Anabaena variabilis* M3. *Nucleic Acids Res* 23:2161-2167

Doherty HM, Adams DG (1995). Cloning and sequence of ftsZ and flanking regions from the cyanobacterium *Anabaena* PCC 7120. *Gene* 163:93-96

Kim ST, Heelis PF, Sancar A (1995). Role of tryptophans in substrate binding and catalysis by DNA photolyase. *Methods Enzymol* 258:319-343

Piechula S, Kur J, Woszczyk J, Podhajaska AJ (1995). Purification and characterization of two restriction endonucleases isolated from *Phormidium inundatum*. *Gene* 157:315-316

Richter S, Messer W (1995). Genetic structure of the dnaA region of the cyanobacterium *Synechocystis* sp strain PCC 6803. *J Bacteriol* 177:4245-4251

Tamada T, Nishida H, Inaka K, Yasui A, Deruiter PE, Eker APM, Miki K (1995). A new crystal form of photolyase (photoreactivating enzyme) from the cyanobacterium *Anacystis nidulans*. *J Struct Biol* 115:37-40

Yebra MJ, Bhagwat AS (1995). A novel repetitive sequence lies near the gene encoding a cytosine methyltransferase in the cyanobacterium *Dactylococcopsis salina*. *Gene* 164:71-74

Zhang CC, Huguenin S, Friry A (1995). Analysis of genes encoding the cell division protein FtsZ and a glutathione synthetase homologue in the cyanobacterium *Anabaena* sp PCC 7120. *Res Microbiol* 146:445-455

Soper BW, Reddy KJ (1995). Distribution and homology of plasmids in several strains of Cyanothecae. *Curr Microbiol* 31:169-173

Tominaga H, Kawagishi S, Ashida H, Sawa Y, Ochiai H (1995). Structure and replication of cryptic plasmids, pMA1 and pMA2, from a unicellular cyanobacterium, *Microcystis aeruginosa*. *Biosci Biotechnol Biochem* 59:1217-1220

Kadyrova GK, Muradov MM, Khalmuradov AG, Koltukova NV, Mendzhul MI (1995). Dynamics of the amino acid pool in the cyanobacterium *Anabaena variabilis* in the early period of cyanophage A-1 development. *Microbiology-Engl Tr* 64:395-398

Koltukova NV, Kadyrova GK, Mendzhul MI, Muradov M (1995). Intracellular proteinases of *Anabaena variabilis* during the early stage of development of cyanophage A-1. *Microbiology-Engl Tr* 64:144-148

Mendzhul MI, Koltukova NV, Lysenko TG, Perepelitsa SI (1995). Comparative physicochemical study of proteinases from native and infected cells of the cyanobacterium *Plectonema boryanum*. *Microbiology-Engl Tr* 64:149-152

Sukhanov SN, Nesterova NV, Mendzhul MI (1995). Characterization of the DNA polymerase activity in the system cyanobacterium *Plectonema boryanum*-cyanophage LPP-3. *Microbiology-Engl Tr* 64:51-55

#### **APPLIED CYANOBACTERIOLOGY**

Asthana RK, Chatterjee S, Singh SP (1995). Investigations on nickel biosorption and its remobilization. *Process Biochem* 30:729-734

Markov SA, Bazin MJ, Hall DO (1995). The potential of using cyanobacteria in photobioreactors for hydrogen production. *Adv Biochem Eng Biotechnol* 52:59-86

Markov SA, Bazin MJ, Hall DO (1995). Hydrogen photoproduction and carbon dioxide uptake by immobilized *Anabaena variabilis* in a hollow-fiber photobioreactor. *Enz Microb Technol* 17:306-310

Pant A, Srivastava SC, Singh SP (1995). Factors regulating methyl mercury uptake in a cyanobacterium. *Ecotoxicol Environ Safety* 32:87-92

Watanabe Y, Delanoue J, Hall DO (1995). Photosynthetic performance of a helical tubular photobioreactor incorporating the cyanobacterium *Spirulina platensis*. *Biotechnol Bioeng* 47:261-269

Ismail BS, Siew TC, Mushrifah I (1995). Effect of molinate and carbofuran on nitrogen fixation by *Azolla pinnata*. *Microbios* 82:127-134

Berthold HK, Crain PF, Gouni I, Reeds PJ, Klein PD (1995). Evidence for incorporation of intact dietary pyrimidine (but not purine) nucleosides into hepatic RNA. (*Spirulina*) *Proc Natl Acad Sci USA* 92:10123-10127

Chauhan VS, Singh G, Ramamurthy V (1995). Eucalyptus kraft black liquor enhances growth and productivity of *Spirulina* in outdoor cultures. *Biotechnol Progr* 11:457-460

Mahajan G, Kamat M (1995). gamma-linolenic acid production from *Spirulina platensis* (Short Contribution). *Appl Microbiol Biotechnol* 43:466-469

Marquez FJ, Sasaki K, Nishio N, Nagai S (1995). Inhibitory effect of oxygen accumulation on the growth of *Spirulina platensis*. *Biotechnol Lett* 17:225-228

Mathew B, Sankaranarayanan R, Nair PP, Varghese C, Somanathan T, Amma BP, Amma NS, Nair MK (1995). Evaluation of chemoprevention of oral cancer with *Spirulina fusiformis*. *Nutr Cancer* 24:197-202

Ogbonna JC, Yada H, Tanaka H (1995). Light supply coefficient: A new engineering parameter for photobioreactor design. *J Ferment Bioeng* 80:369-376

Singh G, Chauhan VS, Ramamurthy V (1995). Kraft black liquor for improving the productivity of *Spirulina* biomass. *Biotechnol Lett* 17:771-776

Abdalla MH, Issa AA (1994). Suitability of some local agro-industrial wastes as carrier materials for cyanobacterial inoculant. *Folia Microbiol Prague* 39:576-578

=====

**ADDRESSES\*ADDRESSES\*ADDRESSES\*ADDRESSES\*ADDRESSES**

=====

Send CONTRIBUTIONS to one of the addresses listed below. There is no charge to receive the newsletter electronically, and you may receive the electronic version even weeks earlier than others would receive the printed version. To get on the ELECTRONIC MAILING LIST, send your name, telephone, fax, and E-mail numbers (if any), and a brief description of your research interests for inclusion in the next Directory of Cyanobacteriologists and the name and model number of printer(s) available to you. To obtain a PRINTED VERSION OF THE NEWSLETTER BY MAIL, send \$10 U.S. (please, no checks except in U.S. currency) per year to Jeff Elhai, along with the same information mentioned above (except printer name). If it is difficult for you to send hard currency, send a note indicating your interest.

AUSTRALIA/NEW ZEALAND

Steve Delaney  
Department of Biotechnology,  
University of New South Wales P.O. Box 1  
Kensington, New South Wales  
AUSTRALIA 2033 (Tel) 02-697-2056

AUSTRIA

Georg Schmetterer  
Institut für Physikalische Chemie,  
Währingerstrasse 42, A-1090 Wien  
(Tel) 43-1-31367-2555  
(EMail) A8422dad@Awini11

CANADA

Neil Strauss  
Dept. of Botany,  
University of Toronto,  
Toronto, Ontario M5S 1A1.  
(Tel) 416-978-3532/5563  
(Fax) 416-978-5878  
(E-mail) Straus@Botany.UToronto.Ca

P.R.CHINA

Chao-Tsi Tseng  
Centre of Marine Sciences  
Dept. of Biology  
Nanjing University, Nanjing.

(Tel) 637551-2551  
(Fax) 086025-302728

#### FRANCE

Nicole Tandeau de Marsac  
Physiologie Microbienne  
Institut Pasteur  
29 rue du Dr. Roux  
75724 Paris Cedex 15.  
(Tel) 567-46-98  
(Fax) 40.56.01.25  
(EMail) NTMarsac@Pasteur.Fr

#### GERMANY

Wolfgang Lockau  
Biochemie der Pflanzen  
Fachbereich Biologie  
Humboldt-Universität,  
Invalidenstr. 42, 10 115 Berlin  
(Tel) 30-2897-2686 (Fax) 30-2897-2641

#### INDIA

Joe Thomas  
Biotechnology Division  
SPIC Science Foundation  
110 Mount Road  
Madras 600 032.  
(Tel) 432342 (Fax) 432163

#### ISRAEL

Elisha Tel-Or  
Dept. of Agricultural Botany  
The Hebrew University  
Rehovot 76100  
(Tel) 08-481262

#### ITALY

Mario Tredici  
Departimento di Scienze e Tecnologie  
Alimentari e Microbiologiche.  
Universita degli Studi di Firenze,  
P.le.delle Cascine 27 51044 Firenze.

(Tel) 055-352051 (Fax) 055-330431  
(E-mail) Tredici@Cisma.Fi.Cnr.It

#### NETHERLANDS

Luuc Mur  
Laboratorium voor Microbiologie,  
Universiteit voor Amsterdam  
Nieuwe Achtergracht 127  
1018 WS Amsterdam  
(Tel) 31-20-525-7056  
(Fax) 31-20-525-5802  
(E-mail) A417LMur@Horus.Sara.NL

#### SCANDANAVIA

Olav Skulberg  
Norwegian Institute for Water Research  
P.O.box 69  
Korsvall, N-0808  
Oslo 8 NORWAY.  
(Tel) 47 22 185266  
(Fax) 47 22 185200

#### U.K.

Tony Walsby  
Dept. of Botany  
University of Bristol  
Bristol BS8 1UG.  
(Tel) 0272-303030

#### ANYWHERE ELSE

Jeff Elhai  
Dept. of Biological Sciences  
Florida International University  
University Park Campus  
Miami FL 33199 USA.  
(Tel) 305-348-3584, (Fax)305-348-1986  
(E-mail) Cyano@Servax.Fiu.Edu

=====

