1998

CyanoNews (Vol. 14, No. 1, August 1998)

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CyanoNews

Volume 14 Number 1 + late breaking news (as of 1 Aug 1998)
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Plausibly Asked Questions (PAQs)

How can I most effectively use this newsletter? By treating what you read as the beginning, not the end of the discussion. If you have thoughts on the topic, click on the name of the contact person or contact *CyanoNews* (upper right corner of page). If you want to find out more, click on references that are sometimes embedded, or click on the contact person.

How current is the news in this newsletter? News is posted as it is received (dates of posting are noted in the Table of Contents). Every so often, the oldest items are archived. The current newsletter consists of several months of news.

How does it get to be current? By readers contributing news.

What could I possibly contribute? Funny you should ask. (click here)

How current are the references? References are posted only occasionally, about 2-3 times per year. You can be made aware of this event if you like. How? (click here)

How do I get a printed copy of the *CyanoNews*? *CyanoNews* has been published as a printed newsletter for its first 13 volumes. Most back issues are still available. Starting with Volume 14, the newsletter has been constructed for viewing on the web and embraces the connectivity of that medium. You can use the capacity of your web browser to print out specific items of interest, but a printed version of the entire newsletter does not exist.

The page looks funny. How do I make the words bigger/smaller? You have control over this. If you're using Netscape 3.0, click on Options, General Preferences, Fonts, Choose Fonts (proportional), then play with the font size.

Do I have to plow through the entire references to find those I want? Maybe not. Try using the browser search function (Edit/Find in Netscape) to seek out items of interest in each section.

Do I have to plow through all these questions to get to the newsletter? No (but that was the last one anyway). Just click on Table of Contents here or at the top of the page.

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Bulletin Board

(25 August 1999)
Announcements: Miscellany of cyanobacteriological interest
Meetings and Books: Upcoming meetings, interesting new books (c/o CyanoSite)
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ANNOUNCEMENTS

For the past 13 years, CyanoNews has been composed as a printed newsletter, disseminated by regular mail and, in recent years, by electronic mail as well. Starting with this issue, CyanoNews will be composed as an electronic newsletter, disseminated through the internet, with the goal of speeding up the flow of information amongst cyanobacteriologists. No doubt some problems will accompany this change -- perhaps the newsletter (created using NetScape 3.0) will not function properly with other browsers. Perhaps you don't have a browser and are reading this second hand. If you encounter difficulties obtaining this newsletter, please let me know. Also, please pass on any suggestions you may have.

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Chemicals from Microalgae is the title of a newly published collection of articles edited by Zvi Cohen and published by Taylor & Francis, London (ISBN 0-7484-0515-1). The book includes discussions on the occurrence and physiological roles of these chemicals, methods aimed at enhancing their content, large scale algal biomass production, and downstream processing.

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Cyanobacterial Biotechnology, edited by G. Subramanian, BD Kaushik, and GS Venkataraman, collects papers presented at the International Symposium on Cyanobacateria Biotechnology, held in Trichy, India, September 1996. The volume covers a wide range, including papers considering cyanobacteria as biofertilizer, sources of biomass and specialty, and objects of less applied research in physiology and ecology. The book is published by Science Publishers (ISBN 1-57808-035-5) and lists for US $96.

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The Proceedings of the Ninth International Symposium on Phototrophic Prokaryotes has been published under the name *The Phototrophic Prokaryotes*, edited by Günter Peschek, Wolfgang Löffelhardt, and Georg Schmetterer. The book (ISBN 0-306-45923-X) is published by Kluwer Academic/Plenum Publishers, listing for US$130 + shipping. A partial table of contents is online.

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A special issue of the journal Environmental Toxicology and Water Quality Volume 14 no.1, 1999) is devoted **cyanobacterial toxins**. The issue, edited by Ian Falconer, contains 24 papers (219 pages) on a range of issues on toxic cyanobacteria,contributed

from across the world. Copies of this issue can be purchased from the publisher, John Wiley & Sons for a low price.
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The World Health Organization monograph ***Toxic Cyanobacteria in Water - a guide to their public health consequences,monitoring and management*** (ISBN/ISSN: 0-419-23930-8), has been published by E & FN Spon, 11, New Fetter Lane, London, EC4P 4EE. It runs to 416 pages and covers occurrence, toxicology, health, management of water, water treatment, and lab methods.A summary and complete table of contents is available at the publisher's web site.The monograph lists at UK 24.99 pounds.
* * * * * * * * * * * *

Photosynthesis Research recently put out a special issue entitled, Molecular approaches to light acclimation from cyanobacteria to higher plants. The issue included articles on the molecular basis underlying regulation of chromatic adaptation, antennae in oceanic picophytoplankton, and PSI/PSII stoichiometry. The special issue was Volume 53 No. 2-3 (August/September 1997).
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In 1997, its first full year after publication, Kaneko et al [(1996) DNA Res. 3 (Jun): 109-136], announcing the completion of the sequence of *Synechocystis* PCC 6803, was cited 130 times. Of course, this is a gross underestimate of the references to the work by the Kazusa group, since many papers refer directly to the CyanoBase web site rather than to the article describing the sequence.

POSITIONS AVAILABLE

Position offered:	**Post Doc**
Contact:	**Frédéric Partensky**, E-MAIL: partensky@sb-roscoff.fr; TEL: 33 2 98 29 23 14; FAX: 33 2 98 29 23 24 **Daniel Vaulot**; E-MAIL: vaulot@sb-roscoff.fr; TEL: 33 2 98 29 23 34; FAX: 33 2 98 29 23 24 Oceanic Phytoplankton team, Centre National de la Recherche Scientifique, UPR 9042 and University Paris 6, Station Biologique, BP 74, 29682 Roscoff cedex, FRANCE Web site: http://www.sb-roscoff.fr/Phyto/phyto_en.html
Research:	Genotypic analysis of world populations of marine cyanobacteria. Click here for details.
Send:	For forms and eligibility for Marie Curie fellowship, see http://www.cordis.lu/improving/calls/mcfi_199901.htm. Deadline for application March 22, 2000. If interested, contact D.V. or F.P.(above) and include a CV.

Position offered: **Post Doc**

Contact: Peter Lindblad, Dept Physiological Botany, EBC, Uppsala Univ, Villavägen 6, S-752 36 Uppsala, Sweden. TEL & FAX: +46 18 - 471 28 26; E-MAIL: Peter.Lindblad@fysbot.uu.se

Research: Work with cyanobacterial hydrogen metabolism. Includes molecular characterization as well as experiments using bioreactor. See Tamagnini P et al [(1998) Appl Environ Microbiol 63:1801-1807], Oxelfelt F et al [(1998) Arch Microbiol 169:267-274], Lindblad P et al [(1998) In: Biohydrogen, Zaborsky OR et al, eds. Plenum Press, New York. pp53-63], Axelsson R et al [(1999) FEMS Microbiol Lett 170:77-81], Boison G et al [(1999) FEMS Microbiol Lett 174:159-165].

Position offered: **Post Doc**

Contact: Mário Fragata, Départment de Chimie et Biologie, Section de Chimie, Université du Québec à Trois-Rivières, Trois-Rivières, Que, G9A 5H7, CANADA, TEL: 819-376-5077, FAX: 819-376-5057, E-MAIL: fragata@uqtr.uquebec.ca

Research: Study of (a) the structural and functional aspects of the anionic and nonionic lipids in the thylakoid membrane of plant chloroplasts (lipid-protein interactions), and (b) the role of the thylakoid lipids on the protection of the photosynthetic membrane against the deleterious effects of temperature.

Available: September 1999, for one year

Position offered: **Postdoc**

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: Microbial development and genetics. Regulation of developmental pattern formation and programmed DNA rearrangements during heterocyst differentiation in the cyanobacterium Anabaena sp. strain PCC 7120. See: Science 282:935-938 (998), Mol. Microbiol. 3:1241-1250 (1997). Key words: Microbiology, Developmental Biology,

	Molecular Biology.
Requirements:	Ph.D. Applicants should have expertise in molecular biology, biochemistry, and microbial genetics. Strong preference will be given to highly motivated individuals with a proven record of quality publication and to those with potential for obtaining independent funding.
Send:	Cover letter, CV, and three letters of recommendation.
Salary:	Negotiable
Available:	Immediately
Position offered:	**Post-Doc**
Contact:	Fevzi Daldal, Department of Biology, University of Pennsylvania, Philadelphia PA 19104-6018, U.S.A. Tel: 215-898-4394; Fax: 2215-898-8780; E-mail: FDaldal@sas.UPenn.Edu
Research:	Structure, function, biogenesis, and regulation of expression of cytochromes and cytochrome complexes of photosynthetic bacteria [see J Bacteriol 178:5279-5290 (on cyt *c* biogenesis; Biochem 36:11675-11696, Biochem 37:8105-8114, Biochim Biophys Acta 1319:99-108 (on cyt bc_1 complex); J Bacteriol 180:969-978 (on cyt cbb3 oxidase); J Bacteriol 179:2623-2631, Biochem 37:5501-5510 (on cyt *cy*)]
Requirements:	Solid background and experience in either molecular biology and genetics or protein biochemistry and spectroscopy; desire to learn multidisciplinary approaches
Salary:	Commensurate with experience
Send:	CV, description of research accomplishments, references
Available:	Now

TRANSITIONS

David Hall

David Hall passed away early on Sunday morning, 22 August. David died of pancreatic cancer which had been diagnosed last year. He was working enthusiastically to the end and calling me into the hospital to assist with his work. He was still making arrangements for his 5 PhD students viva's on Sat night, finishing off reports and papers, organizing the new chief editor for the

Biomass and Bioenergy journal and working on many of his various projects.
His family were with him, his wife Peta, his two daughters Elena and Claire, his brother Michael from USA, cousins from South America and other close family members. Messages for the family can be sent here at King's College, London, using David's e-mail (david.hall@kcl.ac.uk).
- Marian Mackenzie-Ross

CONRAD MULLINEAUX recently heard of a distressing rumour circulating in the cyanobacterial community to the effect that he is dead. He hopes that you will be pleased to learn that he is alive and well (at least to date - 28th April 1999). He hopes to stay that way, although he daily risks his life by cycling in London. (a nontransition)

KARL FORCHHAMMER has moved from Universität München to the University of Giessen.

> Institut für Mikrobiologie und Molekularbiologie Frankfurter Str. 107, D-35392 Giessen, GERMANY. Tel: (49) 641 99-35545. Fax: (49) 641 99-35549. E-mail: Karl.Forchhammer@mikro.bio.uni-giessen.de

IAN FALCONER has retired from his position at the University of Adelaide. What would ordinarily represent a loss for us in this case is a cause for rejoicing, for he is relinquishing his duties in the higher administration of the University of Adelaide in favor of a return to full time research in the Cooperative Research Center for Water Quality and Treatment, located in the Department of Pharmacology.

> Department of Clinical and Experimental Pharmacology,University of Adelaide Medical School,Adelaide 5005, AUSTRALIA. Tel/Fax: 61-8-8303-4257. E-mail:ifalconer@medicine.adelaide.edu.au

JOHN GOLBECK has a long standing interest in PSI. Now he tells us of a new interest in PSU, Pennsylvania State University, to which he has moved from his former home at University of Nebraska.

> S309 Frear Building, Department of Biochemistry and Molecular Biology, The Pennsylvania State University, University Park, PA 16802 USA. Tel: 1-814-865-1163 (Office), 1-814-865-1162 (Student office and laboratory); Fax: 1-814-863-7024; E-mail:JHG5@psu.edu

NAOKI SATO has moved his lab from Tokyo Gakugei University to Saitama University, but his interest in RNA binding protein remains constant.

> Department of Biochemistry and Molecular Biology, Faculty of Science, Saitama University, Tel: 81-48-858-3623, Fax: 81-48-858-3384, E-mail: naokisat@molbiol.saitama-u.ac.jp, Web: http://brahman.phy.saitama-u.ac.jp/~naokisat

MINGTAO ZENG has moved from Tel Aviv University (the lab of Chanoch Carmeli) to the University of California at Berkeley to work with Richard Calendar.

> Department of Molecular and Cell Biology, University of California at Berkeley, 401 Barker Hall, Berkeley, CA 94720-3202 U.S.A. Tel: 1-510-6425915; Fax: 1-510-6435035, E-Mail:mtch@uclink4.berkeley.edu

News

(updated January 1999)

News Items

Structure of cyano drug showcased

Plasmid that facilitates conjugation described

First gene of cyanophycin metabolism cloned

Specifity of association of *Nostocs* in lichens

Phormidium flees fearsome foe

Dramatic intervention saves community from *Microcystin* bloom

Meeting Reports

Vth International Conference on the Molecular Biology of Hydrogenases

Commentary (updated 22 January 1999)

IXth International Symposium on Phototrophic Prokaryotes

Commentary (updated 13 August 1998)

(Note: Meeting reports, by necessity, cannot be exhaustive. To retain one's sanity, a reporter must put aside the natural inclination to pay respect to everyone's contribution and instead focus on a few presentations of personal interest. Many other presentations deserving of notice are therefore left unmentioned.)

Structure of Cyano Drug Showcased

Nature Structural Biology has just gone online as an electronic journal, and anxious to put their best foot forward, the editors chose a cyanobacterial piece of work as the lead article: Solution structure of cyanovirin-N, a potent HIV-inactivating protein [Bewley et al (1998) Nature Struct Biol 5:571-578]. Cyanovirin is a 101 amino acid peptide produced by Nostoc ellipsosporum, unlike any other protein thus far characterized. It has generated interest by its ability to inactivate HIV by interacting with the virus' surface envelope glycoprotein gp120. The protein has been overproduced in E.coli, good news for those interested in clinical trials. Unfortunately, for those more interested in cyanobacteria, the natural function of the protein is a complete mystery.

Contact: Marius Clore (clore@speck.niddk.nih.gov)
or: Angela Greenborn (gronenborn@vger.niddk.nih.gov)

Plasmid that Facilitates Conjugation Described

Many laboratories have made use of plasmids designed to facilitate the transfer of DNA by conjugation from E.coli into cyanobacteria, plasmids that were constructed in Peter Wolk's lab in the late 1980's and early 1990's. The most widely used, pRL528, carries genes encoding methylases that can protect transferred DNA from restriction by AvaI and AvaII. More recently, plasmid pRL623 has added protection against AvaIII. Those who have used these plasmids have never had an article to cite, one that described the plasmids' construction... until now! Finally, Wolk's lab has published an article that relates the properties of helper plasmids that permit efficient conjugation into Anabaena PCC 7120. Those inclined may cite: Elhai et al (1997) J Bacteriol 179:1998-2005. The article may serve also as a reference for pRL443, a kanamycin-sensitive derivative of RP4 used by many as a conjugal plasmid.

First Gene of Cyanophycin Metabolism Cloned

Cyanobacteria are the only organisms on earth known to synthesize cyanophycin, a polypeptide storage polymer composed of arginines linked to ß-carboxy groups of aspartates. The polypeptide is made not by ribosomes but by the enzyme cyanophycin synthetase. Karl Zeigler and others in the lab of Wolfgang Lockau have made a considerable advance in the study of cyanophycin by cloning the gene from *Synechocystis* PCC 6803 encoding the synthetic enzyme.

Cyanophycin synthetase was first purified from *Anabaena variabilis* owing to the relatively poor yield and stability of the same enzyme from *Synechocystis*. Six partial amino acid sequences were sufficient to identify an unidentified open reading frame (slr2002) in CyanoBase potentially encoding a protein of approximately the same molecular weight (96 kDa) as cyanophycin synthetase from *Anabaena*. The gene was cloned by PCR and expressed in *E. coli*.

The resulting production of cyanophycin in *E. coli* shows unequivocally that the protein product of a single gene is sufficient for the synthesis of cyanophycin. Both the biochemical characteristics of the enzyme and the sequence of the gene that encodes it suggests a relationship with peptide synthetases responsible for peptidoglycan biosynthesis.

Cyanophycin has long inspired speculation as to its role in nitrogen metabolism. Is it a dynamic store, as suggested by Noel Carr? Perhaps its metabolism contributes to the spacing of heterocysts? It clearly will not be long before we hear about mutants defective in cyanophycin metabolism and these speculations can be put to the ultimate test.

This work has recently appeared in Eur J Biochem (1998) 254:154-159.

Specifity of Association of *Nostocs* in Lichens

A generality that seems to be emerging is that there is little specificity governing symbiotic interactions between *Nostocs* and plants (*1,2*). A cyanobacterium isolated from Yugoslavian soil can infect a *Gunnera* from New Zealand. A strain isolated from the coralloid roots of a cycad can form a productive symbiosis with the bryophyte *Anthoceros*. Per Paulsrud and Peter Lindblad of the University of Uppsala and Jouko Rikkinen of University of Helsinki have made surprising observations (*3,4*) that casts doubt on this generality.

Paulsrud et al amplified and sequenced the tRNA-Leu region from DNA isolated from *Nostocs* cyanobionts of bi- and tripartate lichens. The lichen were taken from different sites in Sweden and Finland. The tRNALeu gene from *Nostocs* contain an intron of highly variable sequence, making it useful for basing phylogenetic inferences. Using the intron sequence as a marker, they found a variety of different *Nostoc* strains within the lichens collected, but in general, each strain was associated with a single fungal species.

How can one reconcile the apparent specificity of cyanobacterial-fungal associations with the lack of specificity observed with associations with plants? It is difficult to argue that diversity in plant associations was found in lab reconstitutions (where plants were not given a choice of *Nostocs*) while specificity was found in the field, because some field studies with plants have also demonstrated cyanobiont diversity at different sites (*5,6*). Paulsrud et al suggested that the difference seen with lichen may result from the ability of a single lichen to fragment and disperse over huge distances, perhaps even globally.

1. Enderlin CS, Meeks JC (1983). Planta 158:157-165
2. Johansson C, Bergman B (1994). New Phytol 126:643-652
3. Paulsrud P, Lindblad P (1998). Appl Environ Microbiol 64:310-315
4. Paulsrud P et al (1998). New Phytol in press
5. Zimmerman WJ, Bergman B (1990). Microb Ecol 19:291-302
6. West NJ, Adams DG (1997). Appl Environ Microbiol 63:4479-4484

Phormidium Flees Fearsome Foe

One might imagine cyanobacteria, residing at the bottom of the food chain, to be an organism made to be eaten, and of course they are, in prodigious amounts. Have they nothing to say on the matter? Surprisingly, they do, claim Edyta Fialkowska and Agnieszka Pajdak-Stós of Jagiellonian University in Krakow.

Noting that ciliates that were fed cyanobacterial mats showed signs of starvation long before the food supply was exhausted, Fialkowska and Pajdak-Stós decided to look at the means by which the prey, mat-forming *Phormidium*, escape predation. After ruling out poisoning by the cyanobacterium, they focused on the curious observation that cyanobacterial filaments protruding from mats exposed to hungry ciliates almost always ended in empty sheaths. What happened to the trichomes that normally inhabit the sheaths?

It turns out that attack by a ciliate prompts at least one strain of *Phormidium* to retract itself into its protective sheath, a process that takes seconds. When confronted by the now empty sheath, the ciliate gives up and goes away. Those trichomes that do not respond fast enough get sucked out and eaten by the ciliate. These results have been published in the Proceedings of the Royal Society of London B [(1997) 264:937-941], but it remains for future research to uncover the molecular mechanism by which the cyanobacterium detects its danger and makes its escape.

Dramatic Intervention Saves Community from Microcystin Bloom

Bill Harding (Dept. of Scientific Services, Vlaeberg, South Africa) has sent in an account of a cyanobacterial attack on the vitality of a community and the bold measures that were used to fight back.

During late 1997, a partial collapse of sago pondweed in the Wildevoelvlei wetland, situated on the west coast of South Africa, resulted in a dense bloom of *Microcystis aeruginosa*. The wetland is a shallow 25 hectare system that is perennially hypertrophic, owing to an influx of between 4 and 7 megaliters of treated wastewater effluent per day.

Shortly after the onset of the bloom, the hepatotoxins microcystin-YR and -LR were detected in freeze-dried algal extracts. Subsequently, the same toxins were detected in the tissue of mussels collected from the reef adjacent to the wetland outflow to the sea. An immediate ban was placed on the collection of shellfish by a community that normally relies on this resource for both food and income.

Bill proposed a vigorous response to the challenge, based on his experience that *M. aeruginosa* has a low tolerance for salinity, while desirable components of the wetland biota can withstand an elevation of salinity to between 7 and 10 parts per thousand (ppt) for a short period of time.

After lowering the water level of the wetland, 600 tons of course rock salt were added to approximately 50,000 cubic meters of water in two applications spaced seven days apart. Effluent from wastewater treatment was curtailed for the duration of the operation. The salinity rose to 3.5 ppt after the first application and to 8 ppt after the second. There was an immediate decline of the *M. aeruginosa* bloom, with the concentration of chlorophyll-a falling from 700 to 150 µg/l during the first week. Thereafter, the cyanobacterium was replaced by a bloom of *Kirchneriella*, followed by a clear water phase (chlorophyll-a less than 5 µg/liter). At this point, the wetland became dominated by chlorophytes and diatoms, together with the zooplankton Daphnia longispina. Salinity began to decline 14 days after the initiation of the operation, when it became necessary to resume the release of effluent. The ambient salinity of the system had returned to zero after about 50 days. The restrictions on harvesting were lifted at the same time.

The bold increase of salinity on this scale demonstrated the value of this environmentally-sensitive intervention for use in coastal lakes and estuaries where conditions allow. The short-term elevation of the ambient salinity of this previously estuarine system resulted in the rapid and total eradication of the toxin- producing cyanobacterium and the concomitant alleviation of the risks to human and animal health in both the freshwater and marine environments. The application further highlighted the intrinsic value of retaining estuarine character and tidal interaction in coastal lake systems that have been altered through human development.

[A more detailed account has been submitted to Harmful Algae News and will also be presented at the 1998 Societas Internationalis Limnologiae meeting in Dublin this year]

Meeting Report

Vth International Conference on the

Molecular Biology of Hydrogenases

by Alfred Hansel

Preceded by the futuristic sounds of Pink Floyd, Paulette Vignais welcomed about 150 scientists dedicated to the study of hydrogenases to the French town Albertville, 12 - 17 July 1997. There in the heart of the Savoy alpine region, the participants were pleased not only by the beautiful surroundings, the delicious meals, and the excellent French wines, but also by the very well organized meeting. The presentations gave a good overview of recent progress concerning the structure and function of hydrogenases.

Peter Lindblad (Uppsala University, Sweden), summarizing the current knowledge about hydrogenases in *Nostoc* PCC 73102, pointed out that cyanobacteria contain at least two different types of enzymes acting on hydrogen. Reversible hydrogenases catalyze both the uptake and evolution of hydrogen, whereas uptake hydrogenases are able only to consume hydrogen. Unlike *Anabaena variabilis*, *Anabaena* PCC 7120, and *Nostoc muscorum*, *Nostoc* PCC 73102 seems to possess only an uptake hydrogenase. Fredrik Oxelfelt from Lindblad's group succeeded in cloning two genes, *hupS* and *hupL* encoding this hydrogenase. The deduced amino acid sequences of *hupS* and *hupL*, reveal an overall similarity of about 90% to the corresponding genes of *Anabaena* PCC 7120, which were recently cloned by Claudio Carrasco in Jim Golden's lab. As in *Anabaena*, *hupS* and*hupL* from *Nostoc* appears to form an operon. However, *hupL* from *Nostoc* differs from the gene in *Anabaena* in that it is not interrupted by a DNA element that is excised during heterocyst differentiation. The group is currently trying to knock out the *hupL* gene in *Nostoc* in order to study the influence of the uptake hydrogenase on the physiology of this strain.

Oliver Schmitz, while working in Hermann Bothe's lab in Cologne (he's now with Susan Golden), found that the organization of the genes encoding a reversible hydrogenase in *A. variabilis* differs somewhat from that in other bacteria. The genes *hoxFUYH* (encoding a functional reversible hydrogenase) form a cluster in this strain, whereas the *hoxF* gene is separated by about 6 kB from the contiguous *hoxUYH* cluster in the unicellular *Synechococcus* PCC 6301.

Gudrun Boison, also in Bothe's lab, not only cloned these genes from *Synechococcus* but also showed that a *hoxH*-negative mutant is unable to evolve hydrogen. Her results indicate the presence of another hydrogenase, putatively of the uptake type, in *Synechococcus*.

Jens Appel, working with Rüdiger Schulz (Marburg University, Germany), was able to clone genes encoding a reversible hydrogenase in *Synechocystis* PCC 6803. The gene cluster shows an organization different from the two clusters known in *Anabaena variabilis* and *Synechococcus*. Physiological studies of a *hoxH* mutant indicate a link of the action of reversible hydrogenase to photosynthesis. In this mutant the ratio of PSI

to PSII is 1 instead of 2. This observation implies that hydrogenase could be connected to cyclic electron transport around PSI, when light reactions are faster than dark reactions, thus functioning as an electron valve. A scan of the complete sequence of *Synechocystis* could find no genes similar to those known to encode uptake hydrogenases.

The group of Yasuo Asada (Tsukuba, Japan) is trying to express foreign hydrogenases in cyanobacteria, which then might be grown for biological hydrogen production in bioreactors. Towards this end, Masato Miyake introduced hydrogenases from *Clostridium pasteurianum* and *Thiocapsa roseopersicina* directly into *Synechococcus elongotus* by electroporation. Both enzymes are stable in the presence of O2, so they might work in cyanobacteria. The presence of the enzymes in the cyanobacterium was shown by Western blot analyses.

As an alternate approach, Y. Koike, from the same group, altered the ribosome binding sequence preceding the gene from *C. pasteurianum* to one more similar to cyanobacterial sequences. After the construct was introduced into *Synechococcus* PCC 7942, he could demonstrate the presence of the hydrogenase. Enzyme activity is another matter, and it remains to be seen if transfer of the structural gene is sufficient to get a functional enzyme complex in such a distantly related organism.

Meeting Report

Molecular Biology of Hydrogenases

Commentary

(Updated 22 January 1999)

The report by Alfred Hansel regarding the recent Hydrogenase meeting missed a point brought out by Gudrun Boison that unicellular cyanobacteria have *hoxE* as well as *hoxF* genes. They were cloned from *Synechococcus* in two different lambda inserts, and restriction analysis indicates that they are at least 16 kb apart from each other and maybe much further. The work has been published [Boison G et al., 1998: Curr. Microbiol 36(5): 253-258].

Vienna

Meeting Report

International Symposium on Photosynthetic Prokaryotes

The flower of cyanobacteriology (and others) descended on Vienna, Austria 6-12 September 1997 for the IXth International Symposium on Phototrophic Prokaryotes. They were met by a variety of interesting presentations and, one night, a forest of bowling pins larger than some of the participants. By the end, the U.S. team had emerged victorious in bowling, and all had come out ahead in science. Our memories must suffice until the next ISPP meeting in Barcelona in the year 2000.

To aid in those memories, several participants have put together their own reminisces of a few themes that struck them:

Macro Bowling

ABC transporters
Ecology
Hydrogenase: Is it relevant for electron flow?
Mobile electron carriers
Signal transduction through PII protein
Heterocyst differentiation

U.S. team

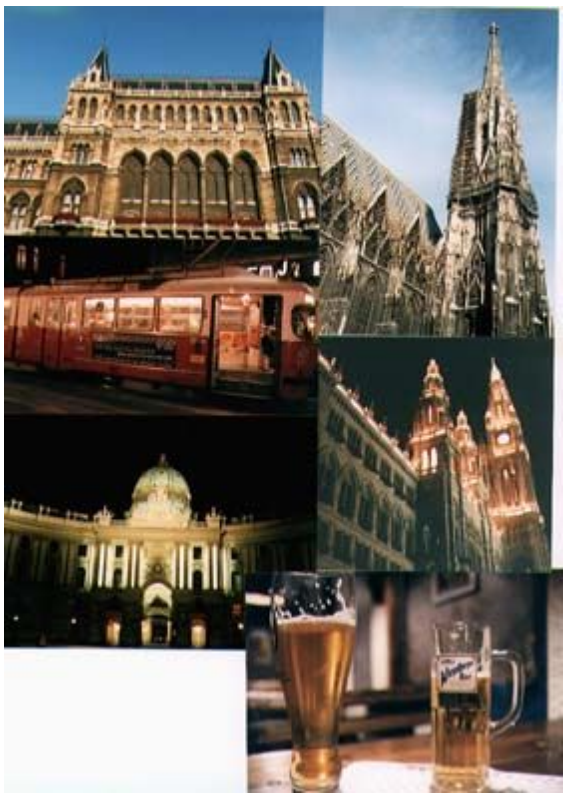
Meeting Report

International Symposium on Photosynthetic Prokaryotes

Commentary

(Updated 13 August 1998)

Chris Nomura's summary of presentations from the recent ISPP meeting in Vienna stated that no one has yet purified the protein product of *cytM*, an electron carrier that may partially substitute for cytochrome c6 and plastocyanin. Georg Schmetterer points out that in fact cytochrome c-M protein HAS been isolated, in Dave Krogmann's lab.



Photography by Toshio Sakamoto (Pennsylvania State U.)

Vienna

(I don't have the postcard, so I can't
tell you what these buildings are.
Günter? Wolfgang? Georg?)
(The bottom right are not buildings.
It just seems that way late late at night)

Photography by Toshio Sakamoto (Pennsylvania State U.)

Teruo Ogawa of the Japanese MacroBowling team takes aim.
Note the line of sight of the observers to get an estimate of the height of the monsters he's aiming at.

Photography by Toshio Sakamoto (Pennsylvania State U.)

International Symposium on Photosynthetic Prokaryotes Meeting Report

ABC transporters in phototrophic prokaryotes

by Gabi Fiedler (U. Regensburg)

Transport systems of the ABC (ATP-Binding Cassette) superfamily facilitate ATP-dependent import and export of a great variety of substrates and are common in bacteria and eukaryotes. Usually the genes encoding these multiprotein complexes are organized in operons.

Victor Bartsevich in Himadri Pakrasi's lab (Washington University, St. Louis) presented his work on the ABC transporter system for manganese in *Synechocystis* PCC 6803. Deletion of one of the subunits of this Mn2+importer results in reduced growth rates in Mn2+-deficient medium under photoautotrophic conditions due to deficiency in Mn2+-containing PSII. The transporter consists of an ATP-binding protein (MntA), a periplasmic substrate-binding protein (MntC) and an integral membrane protein (MntB) with eight putative transmembrane regions. Two alpha/beta domains were predicted from the sequence, possibly forming a cleft where the substrate binds. A Ca2+-binding loop was also predicted, and Victor discussed the possibility that Ca2+ binding may be involved in stabilization of MntC. In addition to the high affinity ABC transporter that is induced in a Mn2+-deficient medium (< 0.5 µM), a second transport system for Mn2+ also exists, induced by µM levels of Mn2+.

Ana Valladares from Enrique Flores' group (University of Sevilla) presented evidence of a high affinity ammonium transport system and an ABC-type urea importer in *Synechocystis*PCC 6803, both subject to nitrogen-control mediated by the NtcA transcriptional regulator.

Werner Klipp (Bochum U.) reported that *Rhodobacter capsulatus* possesses two different molybdenum uptake systems. One of them, the high affinity permease, resembles an ABC transporter consisting of ModA (periplasmic binding protein), ModB (integral membrane protein with five membrane-spanning regions) and ModC (ATP-binding component). Molybdenum binds, if present in high concentrations, to the MopAB proteins, which are DNA-binding proteins and repress the transcription of the *modABC* genes as well as the genes for a molybdenum-independent nitrogenase.

Glucosylglycerol (GG) is synthesized by the moderately halotolerant *Synechocystis* PCC 6803 as an osmoprotective compound. Stefan Mikkat (Rostock U.) showed that mutants defective in the genes *ggtA*, *B*, *C*, or *D*, encoding the subunits of an ABC transporter, are deficient in uptake of [14C]GG. The main function of this ABC importer may be the reuptake of GG that leaks out of cells. Unusual for bacterial ABC transporters is the fact that the gene (*ggtA*) encoding the ATP-binding subunit is not contiguous with the genes *ggtBCD* encoding the substrate-binding and the integral membrane protein.

Iris Maldener and Gabriele Fiedler (Regensburg U.) showed that the ABC transporter DevBCA (Development) is essential for maturation of heterocysts of *Anabaena* 7120.

*Anabaena*strains mutated in *devB*, *C* or *A* are able to synthesize heterocyst-specific glycolipids, but their heterocysts lack the laminated glycolipid layer, suggesting that the DevBCA transporter is involved in export of these specific glycolipids or of an enzyme that is essential for assembly of the laminated layer.

International Symposium on Photosynthetic Prokaryotes Meeting Report

Ecology

by Bas Ibelings (Institute for Inland Water Management, Arnhern)

From an ecologists point of view this well organised symposium took a while to gain momentum. The first time I was treated to the phrase "it's function in the natural environment" was well into the third day of the meeting (in Fritz Jüttner's presentation about nostocyclamide, a compound that inhibits growth of other cyanobacteria). Yet, did all of the structures and processes we study not evolve in the natural environment, and is it not in the natural environment that they all have their function? The meeting really came to life with the change to the second poster session - many interesting posters.

Initially I was displeased that even the historic overviews preceded the ecology session on the last day. The presentation by Noel Carr (U. Warwick), however, turned out to be one of the highlights of the meeting for me. Some of his messages were well worth our attention: e.g. the need for a tighter integration of biochemistry and ecology; or the observation that disruption of a gene often does not have any obvious effects: metabolism does not work as a Swiss watch, but has many alternative pathways; or the remark that we saw many beautiful facts but too little speculation during the meeting. I have been attracted to the ISPP meetings by the combination of a specialised subject (phototrophic prokaryotes), with a wide range of presentations, from bioenergetics or molecular biology to the worlds lakes and oceans. I would applaud a restoration of this integrated approach in the next meeting.

The harmful effects of toxic cyanobacteria help to keep alive the interest of water management and funding agencies in our favourite organisms. Reports in the press cause concern among the public during periods of warm stable weather ("*Blue-green algae: one sip will kill you!*" - Dutch press, "*Queen's swans poisoned by outbreak of algae!*"- U.K. press). Geoff Codd (U. Dundee) gave an overview of the occurrence and significance of cyanobacterial toxins, recognition of which has been limited by in part by inadequate detection methods. A sensitive detection method for the widely occurring microcystins is the Protein Phosphatase Inhibition Assay. It is insufficient however to focus solely on these microcystins, as other toxins, e.g. nostocyclin, are also important. Codd finished his presentation with the recommendation that it is necessary to rationalise water management with respect to these toxins and to try to understand their natural function and evolution.

Steven Bell and others at U. Dundee investigated the phenomenon of fish kills, which are often associated with the occurrence of toxic cyanobacteria. Exposure of rainbow-trout to aqueous solutions of hepatotoxins resulted in sub-clinical liver damage. Radioactivity of 14C-labelled microcystin was detected in liver tissue, although microcystins did not show up in HPLC analysis.

Elke Dittmann (Humboldt U.) reported cloning a peptide synthetase gene cluster that is responsible for hepatotoxin biosynthesis in *Microcystis aeruginosa*. The genes may prove useful in the study of toxin expression and in new DNA-based detection methods. She also created *mic-* mutants that may offer the first glimpse into the role of microcystins in cyanobacterial physiology.

Biodiversity is another topic that in some ways spans the gap between science and politics. Ferran Garcia-Pichel presented an interesting poster about the interrelations between productivity, stability and diversity of ecosystems. He used cyanobacterial communities as a model system and quantified productivity (using microsensors and benthic flux chambers), stability against environmental change and diversity (using PCR-amplified 16S rRNA sequences and denaturing gradient gel electrophoresis). Stability was calculated from measurements of productivity and diversity before and after environmental disturbance. Productivity turned out to be only a weak function of diversity, but stability was found to be a strongly dependent on diversity.

Paul Hayes is interested in the genetic diversity of *Nodularia* populations in the Baltic. His poster discussed one of the worries that many plankton-ecologists share: how representative are the cultures that we use in the lab of the diversity of the natural system? To quantify and compare the diversity of natural and cultured *Nodularia*, he amplified an intergenic spacer within the *cpc* operon (encoding phycocyanin) from individual trichomes, both from clonal isolates and from natural populations. Sequence analysis showed three allelic variants of this region from cultured *Nodularia*, and only two from *Nodularia* taken directly from the natural environment.

International Symposium on Photosynthetic Prokaryotes Meeting Report

Hydrogenase in *Synechocystis* PCC 6803

Is it relevant for electron flow from the photosynthetic to the respiratory chain?

by Ioan Ardelean (Inst. Biology, Bucharest)

The discovery of reversible hydrogenase genes in *Synechocystis* PCC 6803 [Appel & Schulz (1996) Biochem Biophys Acta 1298:141-147] was followed by a proposal that the diaphorase part of the enzyme could be shared both by respiratory complex I and hydrogenase [Appel & Schulz; Schmitz and Bothe (1996) Naturwiss 83:525]. During the Vienna meeting some important contributions were explicitly focused on this topic. Crispin Howitt and Wim Vermaas (Arizona State U.) obtained *hox*- mutants in *Synechocystis* PCC 6803 that show almost the same oxygen consumption rates under photomixotrophic (PM) conditions as the wild type. Their conclusion was that HoxE, HoxF and HoxU polypeptides do not act as the NAD(P)H binding/oxidising module of NDH-1, the nature of which remains to be elucidated. Consistent with this, Hermann Bothe (U. Köln) presented evidence showing that a *hoxU* mutant performs respiratory oxygen-uptake unimpaired.

Jens Appel and Rüdiger Schulz (U. Marburg) put forward the hypothesis that during state transition the reversible hydrogenase could function as an electron valve by producing hydrogen, because autotrophic cultures permanently show a low hydrogenase activity. Genetic analysis of *hoxE*, *hoxF*, and *hoxU* mutants as well as their physiological and biochemical characterization are in progress to see if these genes, which show strong sequence similarities to genes of bacterial and mitochondrial NADH dehydrogeases, are really involved in NDH-1 in cyanobacteria.

In my opinion, the involvement of hydrogenase (as a whole or via one/more of its components) in either photosynthetic and/or respiratory electron transport is still an open question, as well as the biological significance of such an involvement. The reversible hydrogenase could serve as one more in a growing list of redox proteins involved in electron flow around PSI in*Synechocystis* PCC 6803 under normal or stressed conditions (light, anaerobiosis, salt, temperature, etc.), a topic abundently illustrated during the meeting.

[Those still hungry for more about hydrogenases might see the meeting report on the Molecular Biology of Hydrogenases]

International Symposium on Photosynthetic Prokaryotes Meeting Report

Mobile electron carriers in cyanobacteria

by Chris Nomura (Pennsylvania State U.)

Now that the entire *Synechocystis* sp. PCC 6803 genome is sequenced, much attention has been given to the study of its mobile electron carriers, especially cytochrome c-M. It has been reported previously that *Synechocystis* has two main mobile electron carriers: plastocyanin and cytochrome-c6. The main carrier for the organism is plastocyanin when copper is present in the growth media. However, if there is little or no copper available, cytochrome substitutes for plastocyanin as the mobile electron carrier, completing the transfer of electrons from cytochrome b6f to either PS-I or a terminal oxidase.

In a previous study [Zhang et al (1994) J Biol Chem 269:5036] , John Whitmarsh's lab (U. Illinois) reported that even with the deletion of *petJ* (encoding cytochrome c6) and growth of the organism in copper free media (repressing synthesis of plastocyanin), *Synechocystis* PCCis still able to grow at near wild type rates. This result suggests that there may be another mobile electron carrier in *Synechocystis* besides plastocyanin and cytochrome c6. One of the possible candidates to fill this role is cytochrome c-M.

The *cytM* open reading frame was originally discovered in *Synechocystis* PCC 6803 by Malakhov et al [(1994) J Plant Physiol 144:259-264]. This initial report indicated that deletion of the gene gives no discernible phenotype when the cells are grown under normal conditions. What about abnormal conditions? John Whitmarsh described the electron transport kinetics of a mutant deficient in cytochrome c6 (by deletion of *petJ*) and plastocyanin (by deprivation of copper) and of a double mutant deficient in cytochromes c6 and c-M (by mutation of *petJ*and *cytM*) and plastocyanin (by deprivation of copper). The results indicate that cytochrome c-M may serve as an electron carrier during photosynthesis. However, with the double mutant, the low levels of plastocyanin would not be high enough to support the degree of electron transfer observed, suggesting that there is yet another mobile electron carrier in*Synechocystis*.

Michael Malakhov (Sta. Zoologica, Napoli) reported that *cytM* was expressed only under conditions of stress (temperature and high light) and not during normal growth conditions.Dietmar Pils (U. Vienna) reported that his group could not delete *cytM* if *petE* (encoding plastocyanin) was deleted. Several groups reported their inability to create double mutants in*petE* and *petJ* under any conditions. This is especially curious since *petJ* mutants are viable, even when grown in the nominal absence of copper, when the levels of plastocyanin should be very low. It appears that while cytochrome cM may serve as an electron carrier in *Synechocystis* PCC 6803, it cannot fully substitute for either plastocyanin or cytochrome c6.

The pathways between different species are similar in some ways but quite divergent in others. Oksana Malakhova (Sta. Zoologica, Napoli) reported the cloning of the *cytM*

reading frame from several other cyanobacterial species including *Synechocystis* PCC 6714, *Synechococcus* PCC 7942, *Anabaena variabilis* M3, and *Prochlorothrix hollandica*. However, *cytM*could not be detected in *Synechococcus* PCC 7002.
The role of cytochrome c-M in any cyanobacterium remains to be elucidated. No one has purified the protein product of the *cytM* reading frame and only Malakhov has detected a transcript. It will be interesting to see the results of future studies of cytochrome c-M and other mobile electron carriers.
(see also *Commentary*)

Meeting Report

International Symposium on Photosynthetic Prokaryotes

Commentary

(Updated 13 August 1998)

Chris Nomura's summary of presentations from the recent ISPP meeting in Vienna stated that no one has yet purified the protein product of *cytM*, an electron carrier that may partially substitute for cytochrome c6 and plastocyanin. Georg Schmetterer points out that in fact cytochrome c-M protein HAS been isolated, in Dave Krogmann's lab.

International Symposium on Photosynthetic Prokaryotes Meeting Report

PII protein and Regulation by Nitrogen

by Shin-ichi Maeda and Makiko Aichi (Nagoya U.)

There were many reports about the cyanobacterial PII protein (encoded by *glnB*). In enteric bacteria, PII is a central signal- transduction protein involved in transcriptional and post- translational regulation of nitrogen assimilation. The PII protein of *Synechococcus* sp. strain PCC 7942 is distinct from that of enteric bacteria in that it is subject to phosphorylation at a serine residue rather than to uridylylation at a tyrosine residue. It remains similar to PII of enteric bacteria in that its modification state is changed in response to the nitrogen status of the cell: the phosphorylation state of the PII trimer changes from a fully dephosphorylated state in ammonium-grown cells to a highly phosphorylated state in the cells subjected to nitrogen starvation. PII is dephosphorylated also when CO2 fixation is inhibited and hence is supposed to play a role in the interplay between inorganic carbon and nitrogen assimilation. While the modification of cyanobacterial PII in response to cellular nitrogen and carbon status is well established, the physiological role of the protein remains unclear.

The importance of PII in the post-translational regulation of nitrate assimilation was related by Hyun-Mi Lee (Institut Pasteur and CSIC). She found that nitrate assimilation is inhibited by ammonium in wild-type *Synechococcus* sp. strain PCC 7942, but it is insensitive to ammonium in a PII-null mutant (MP2). Introduction of the wild-type *glnB* gene into the MP2 mutant by transformation restored the ammonium-responsive inhibition of nitrate assimilation, suggesting that PII inhibits nitrate assimilation in its unphosphorylated form.

Cloning of *glnB* and characterization of PII from two cyanobacteria was reported: *Synechocystis* sp. strain PCC 6803 by Mario García-Domínguez (Universidad de Sevilla-CSIC) andMichael Hisbergues (CNRS, Marseille) and *Nostoc punctiforme* ATCC 29133 by Tom Hanson (University of California, Davis, now at Ohio State U.). PII was shown to be modified by phosphorylation in *Synechocystis* as in *Synechococcus* sp. strain PCC 7942 [Forchhammer & Tandeau de Marsac (1995) J Bacteriol 177:5812-5817]. A *glnB*-deficient mutant of*Synechocystis* was shown to grow photoautotrophycally and photoheterotrophically (in the light in the presence of glucose plus DCMU) but not photomixotrophically (in the light in the presence of glucose). In *Nostoc punctiforme*, on the other hand, Hanson could not obtain a homozygous mutant lacking the wild-type *glnB* gene and inferred that PII is essential for the growth of this cyanobacterium. These results demonstrate that PII is involved not only in regulation of nitrate assimilation but also in other important cellular processes in cyanobacteria.

The molecular mechanism of regulation of the phosphorylation state of PII was greatly advanced by Karl Forchhammer's group (Universität München) through biochemical studies on PII, PII kinase and PII phosphatase of *Synechococcus* sp. strain PCC 7942. PII binds ATP and 2-oxoglutarate (2-OG; a-ketoglutarate), and the binding of ATP and

2-OG to PII facilitates binding of the other substrate. Under physiological conditions, PII is supposed to constantly bind ATP. PII kinase phosphorylates PII-ATP-2-OG complex and the phosophorylated form of PII is resistant to the action of PII-P phosphatase as long as ATP and 2-OG is bound. Upon dissociation of 2-OG from the complex, PII-P is rapidly dephosphorylated by PII-P phosphatase. Thus, the PII functions as the sensor of cellular 2-OG level.

According to this scheme, nitrogen status of the cells indirectly regulates PII phosphorylation. When ammonium is depleted or ammonium fixation is inhibited, depletion of glutamine results in accumulation of 2-OG (the substrate of GOGAT), which in turn results in phosphorylation of PII to activate the nitrate assimilation pathway. When ammonium is added to the cells, on the other hand, rapid consumption of 2-OG would results in dephosphorylation of PII to inhibit nitrate assimilation. It is to be determined whether the intracellular level of 2-OG actually changes in response to the changes in the nitrogen status of the cell. The PII phosphatase and the PII kinase were purified separately from Synechococcus cells. Partially purified PII-P phosphatase acts on histone protein, casein, and the PII protein but not on ATP and pNPP. The phosphatase activity requires 20 mM Mg2+ and belongs to a PP2C type phosphatase family.

Another important finding related to PII was the nitrogen- responsive transcriptional regulation of *glnB*. In *Synechococcus* sp. strain PCC 7942 (described by Hyun-Mi Lee) and*Synechocystis* sp. strain PCC 6803 (described by Mario García-Domínguez), *glnB* was shown to have multiple transcription start sites, transcription from one of which is stimulated by nitrogen depletion in a NtcA-dependent manner. The PII protein level in nitrogen-starved cells of *Synechocystis* was shown to be three-times that of nitrogen-replete cells. Thus, the capacity of PII-mediated post-translational regulation of nitrate assimilation is increased when nitrate assimilation activity is induced.

International Symposium on Photosynthetic Prokaryotes Meeting Report

Control over Heterocyst Differentiation

by Jeff Elhai (U. Richmond)

I believe Noel Carr once posed the question, if there is a gradient of nitrogenous compounds emanating from heterocysts, then why don't vegetative cells distant from heterocysts grow more slowly than those close to heterocysts? Enrique Flores (U. Sevilla) proposed an answer to this question, starting from the premise that filaments of heterocystous strains are composed of connected cells with a common periplasm (there is a single continuous outer membrane). If nitrogenous compounds pass from heterocysts to vegetative cells through successive cytoplasms then, given the capacity of cyanobacteria to store amino acids, a gradient of nitrogen seems inescapable. Enrique supposed instead that amino acids are released from heterocysts into the periplasm, where they bind to amino acid soluble periplasmic transport proteins before they have a chance to diffuse away.

It follows from this scheme that any amino acid that serves as the medium of exchange must be able to support the growth of filaments... from the outside. With this in mind, Enrique's lab has systematically tested all 20 amino acids for their ability to support growth of *Anabaena* PCC 7120. Only a few amino acids were up to the task, most notably: arginine, glutamine, proline, and aspartate. Interestingly, two of these -- arginine and aspartate -- comprise the amino acid subunits of cyanophycin. The idea of a gradient of nitrogenous compounds emanating from heterocysts might be replaced by a cafeteria in reverse: the food passes by in the periplasm and each cell grabs what it can until it is satiated. There's plenty of food for all while it lasts, but the last cells in line go hungry.

Jim Golden (Texas A&M U.) surprised many with news of a gene, *patS* (previously called *hetS*), that suppresses heterocyst formation when present in multiple copy or overexpressed. More amazing yet, the gene encodes a protein only 17 amino acids long, but the open reading frame and specific amino acid sequence are essential for the effect. A *patS* knockout mutant sprouts heterocysts constitutively, despite the presence of a nitrogen source, and in its absence, filaments show LOTS of heterocysts, many contiguous.

Inspired by pentapeptide peptide signals by *Bacillus subtilis* [Lazazzera et al (1997) Cell 89:917] and the preponderance of mutations of *patS* in the five C-terminal amino acids, Jim's lab examined the effect of adding to the growth medium a synthetic pentapeptide based on the final five amino acids of PatS. Remarkably, this peptide completely inhibits heterocyst differentiation, an effect that disappears when the the peptide is hydrolyzed or its sequence changed. Summing up, PatS has many (but not all) of the characteristics one would expect of the diffusible inhibitory signal long postulated to be responsible for patterned heterocyst differentiation.

Paula Duggan (U. Leeds) presented her work showing found that ethionine at a level of 1 µM blocks heterocyst differentiation while having no effect on macromolecular synthesis. Ethionine, an analog of methionine, inhibits the production of S-adenosylmethionine, a substrate of many methylation reactions, suggesting a role for methylation in the regulation of differentiation. The inhibition of differentiation occurs prior to induction of *hetR*, which is the first gene known to be induced in differentiating cells. Interestingly, this is the same stage at which mutants defective in the histone-like protein HU fail [Khudyakov & Wolk (1996) J Bacteriol 178:3572]. HU is important in the initiation of DNA synthesis and (in *E. coli*) initiation is regulated by the methylation state of the DNA. Whether this conceptual connection is pertinent to *Anabaena* remains to be demonstrated.

Francisco Florencio (U. Sevilla) showed Westerns that indicated a high level of isocitrate dehydrogenase (IDH) in heterocysts but virtual absence of GOGAT. This means that there is a large capacity to make alpha-ketoglutarate (a-KG) in heterocysts but no obvious place for it to go, except out of the cell. Perhaps (as suggested to me by Sam Beale) there is an energetic reason why vegetative cells would make glutamate for export to heterocysts while heterocysts specialize in a-KG synthesis -- after all, the reductant required for glutamate synthesis is a valuable commodity in heterocysts, available only by import, while cyclic phosphorylation keep the ATP required by IDH high. On the other hand, the presumed high level of a-KG in heterocysts (and developing heterocysts?) may serve an informational role, telling the cell that it is starving for nitrogen despite the abundance of amino acids. The role of a-KG in regulating PII phosphorylation and dephosphorylation in *Synechococcus* PCC 7942 elucidated by Angelica Irmler and Karl Forchhammer fits well with this idea (see also Meeting Report on PII protein).

Protein phosphorylation may have another connection with heterocyst differentiation. Cheng-Cai Zhang (U. Strasbourg) reported cloning of a gene (*prpA*) encoding a serine/threonine phosphatase and a closely linked gene (*pknE*) encoding a serine/threonine protein kinase from *Anabaena* sp. PCC 7120. Two mutants of *Anabaena*, which lack either the *prpA* gene or the *pknE* gene, grow normally on ammonium- or nitrate-containing medium, but have severely impaired growth under nitrogen-fixing conditions. This Ser/Thr phosphatase, which from the sequence is classified as type PP1/PP2A/PP2B, seems to be different from the PII-P phosphatase of *Synechocystis*, which is a PP2C-type phosphatase.

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Genomics, DNA transfer, and Miscellaneous

RNA and transcription

DNA metabolism and plasmids

Protein metabolism, folding, and transport

Viruses

Genomics, DNA transfer, and Miscellaneous

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Photosynthesis and Energetics

General photosynthesis

Photosystem I

Photosystem II

Phycobilisomes and phycobiliproteins

Chlorophyll and other pigments

Cytochromes

Ferridoxin and flavodoxin

Bioenergetics

General photosynthesis

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Taxonomy, Phylogeny, and Evolution

Structure, Taxonomy, and Preservation

Phylogeny and Evolution

Structure, Taxonomy, and Preservation

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Toxins and other Secondary Metabolites

Characterization and synthesis

Physiological effects

Characterization and synthesis

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How to contribute

(to bottom line)

You'd be amazed how much of what you consider common knowledge is new and provocative to others. What you dismiss as matters of only local interest may well be vital to someone else far away. Think about contributing the following:

News from the bench: Found something interesting? Let us know! There are few predators in our field, and the best way to keep it that way is to cast your vote for the open exchange of ideas. And what better way to solicit helpful comments from your colleagues?

Summary of your thesis: As sad as it may seem, very few people will ever read the magnum opus over which you've shed blood. Tell us your story, and use this as an opportunity to join the active discussion in our community.

Announcements/requests: Looking for a strain? Just published a book? Have a post-doc position available? Let it be known!

Change of life: You may think that your change of jobs or upcoming visit to another lab is of interest only to yourself. Wrong. We want to know, too, partly because it makes our world more interesting and partly because if we only knew you were there we would... who knows?

Summary of a meeting: You just came back from an interesting meeting. Think of all of us who *couldn't* go! Don't wait to be invited, send us your thoughts on a few of the most interesting presentations (an excellent way to preserve what you gained). What if someone else does the same? Not likely, but if so, the meeting probably deserves the attention, and both offerings will be sewn together to form a pleasing whole.

Notice of a future meeting: I hardly ever get any announcements. If notice of an upcoming meeting is going to appear in this newsletter, it's because someone like you thought to pass on the news.

Worried about your English? Don't! The *CyanoNews* staff stands ready to help your ideas find the expression they deserve.

Bottom line: ***Send news!*** (click here)

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And while you're at it, why not send news!