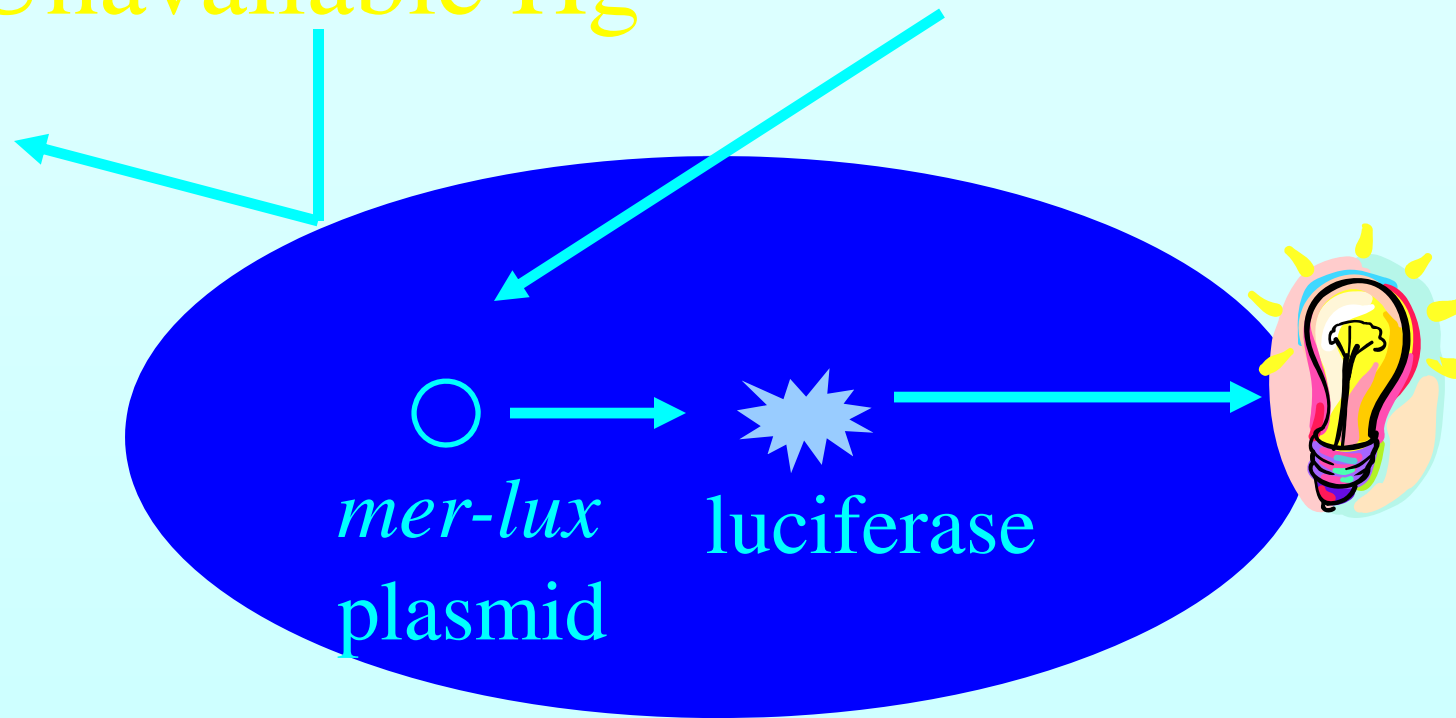


The use of a Genetically Engineered Bioreporter to Study Bioavailable Hg(II) in Natural Waters

J.W.M. Rudd
C.A. Kelly
M. Holoka

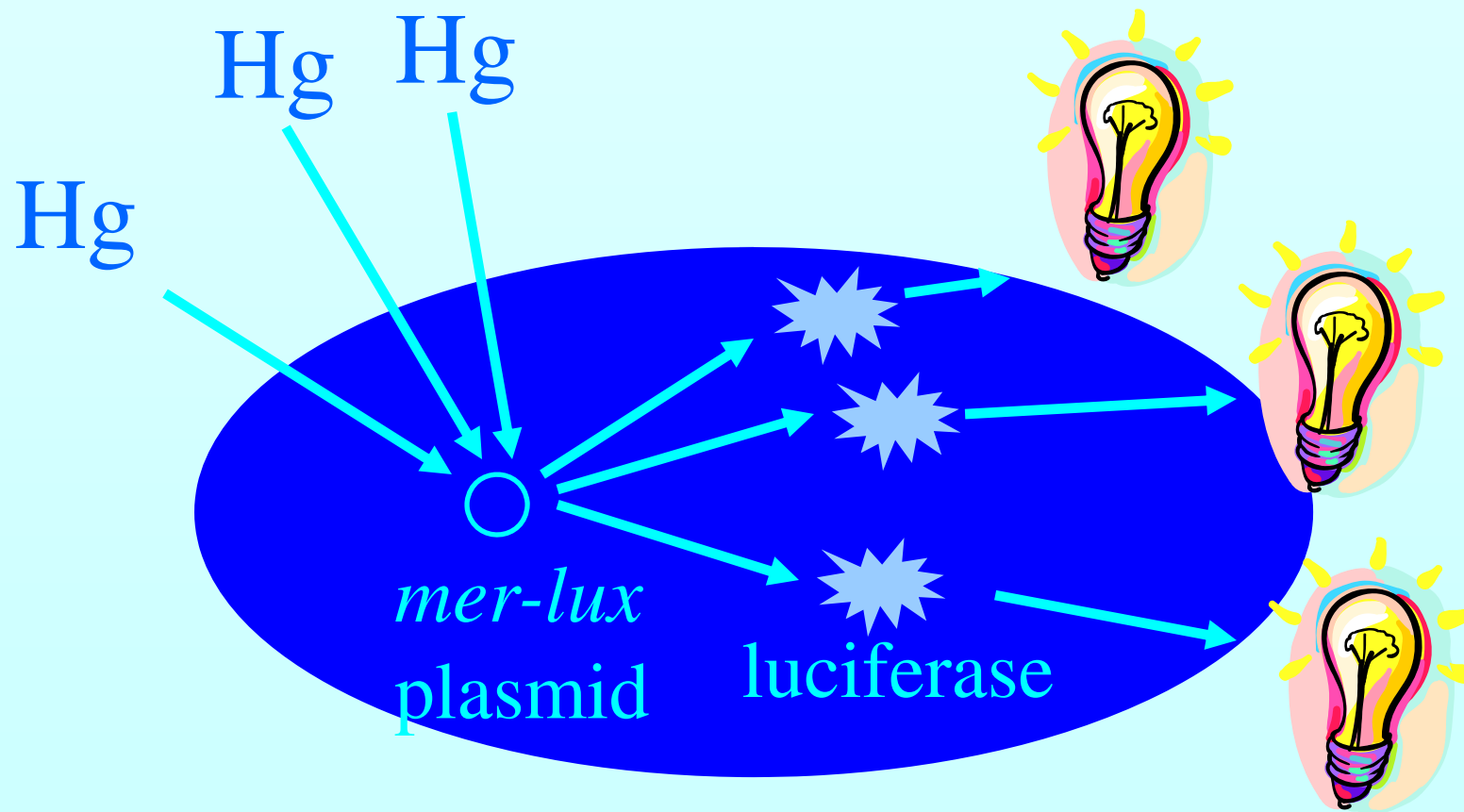
Hg(II) Induced Light Production

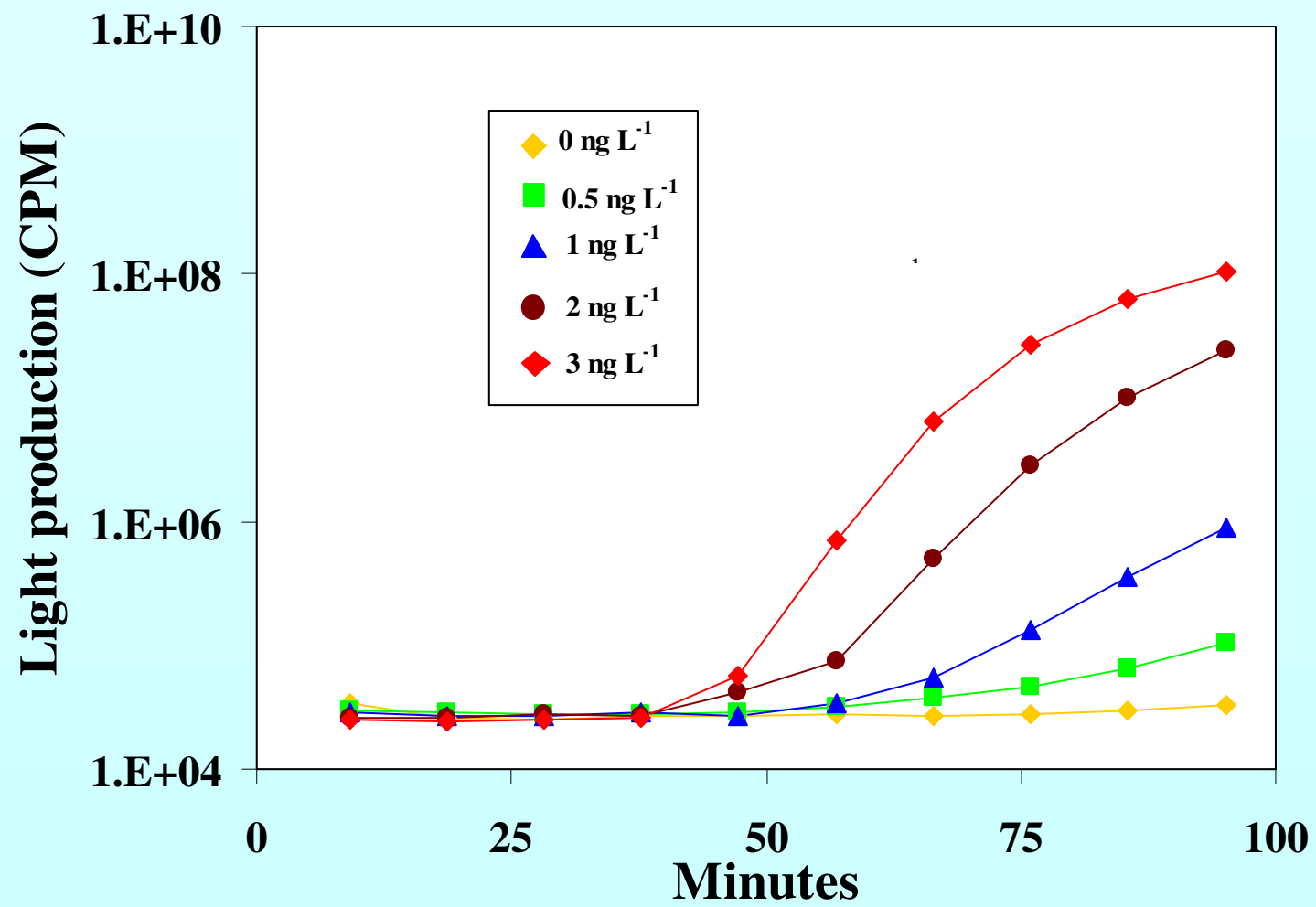
“Unavailable Hg” “Bioavailable Hg”

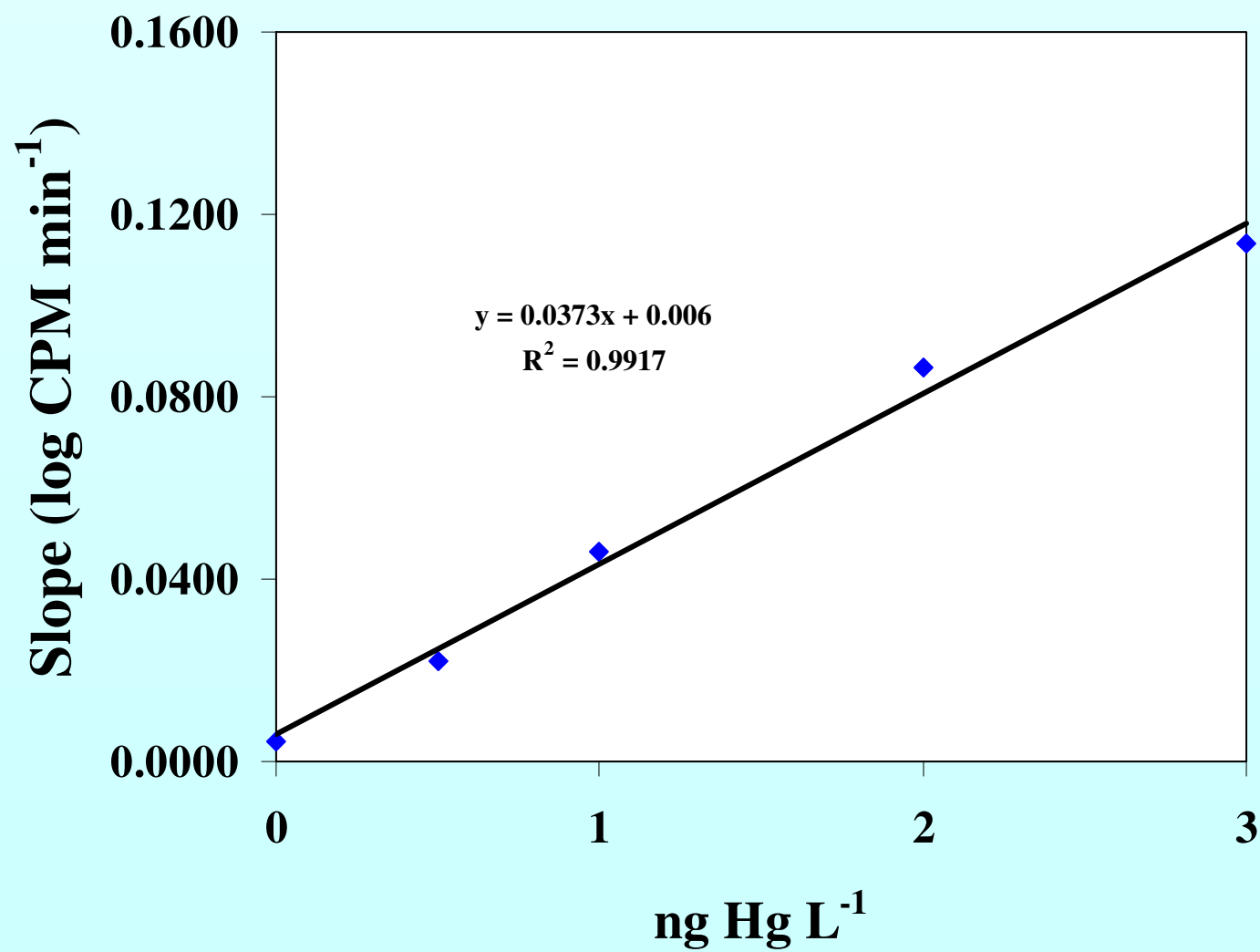


Vibrio anguillarum pRB28 “Bioreporter” Cell

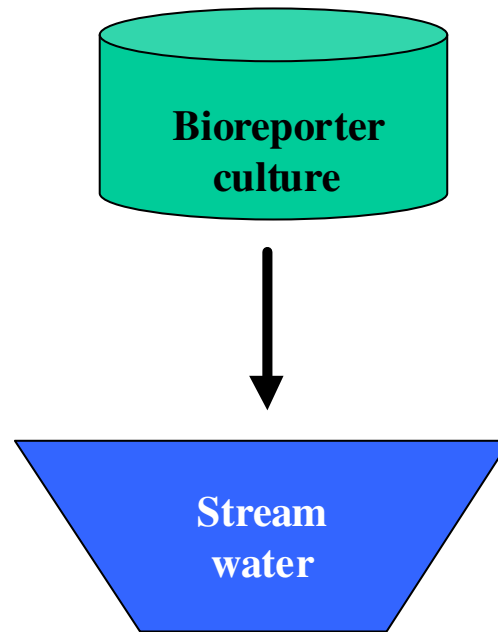
Concentration of Bioavailable Hg







Lab assay of stream water bioavailable Hg



Facilitated uptake of
Hg(II)
by an aquatic bacterium
and effects of changes
in pH

Diffusion

HgX^0

LPS

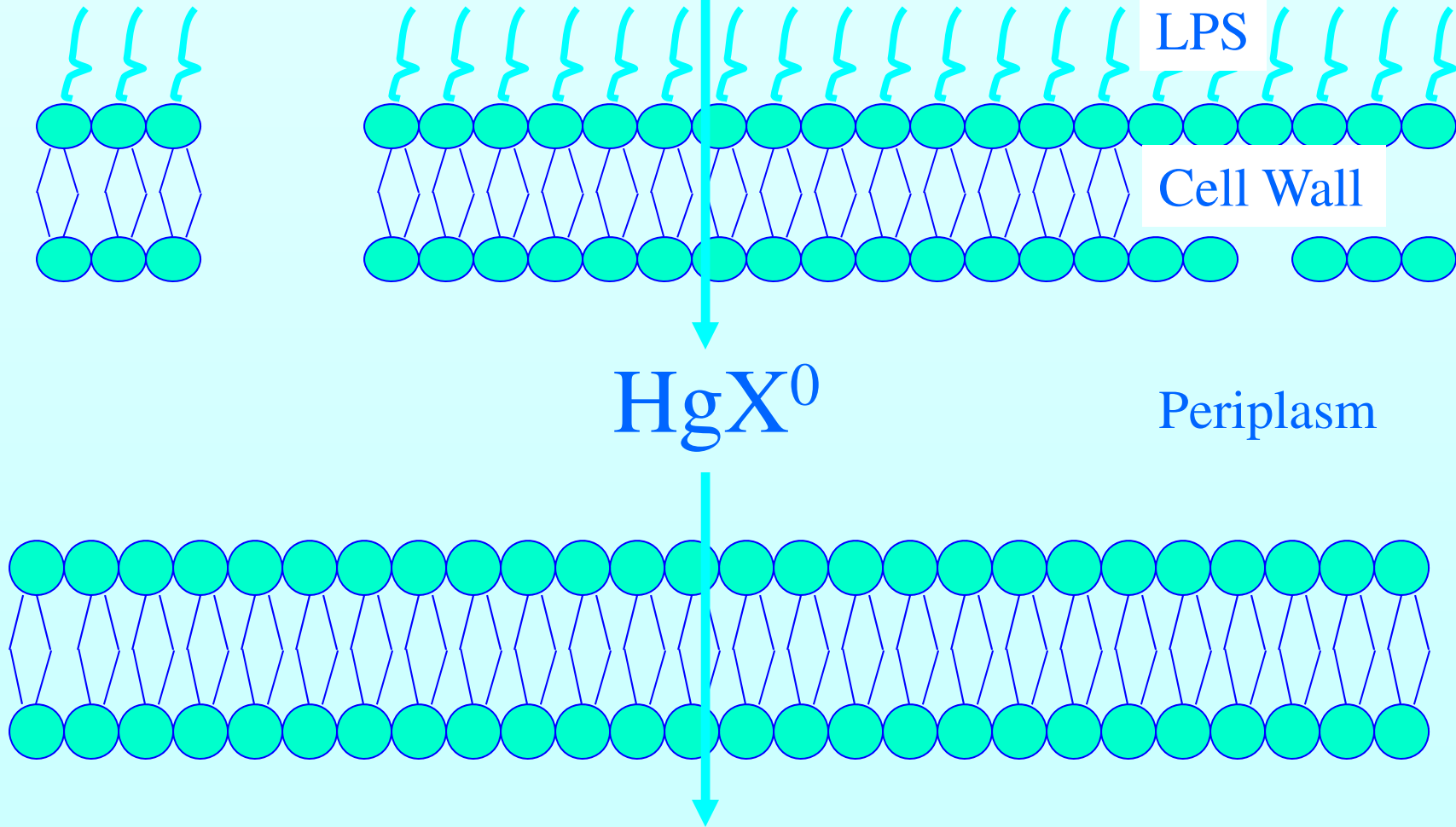
Cell Wall

HgX^0

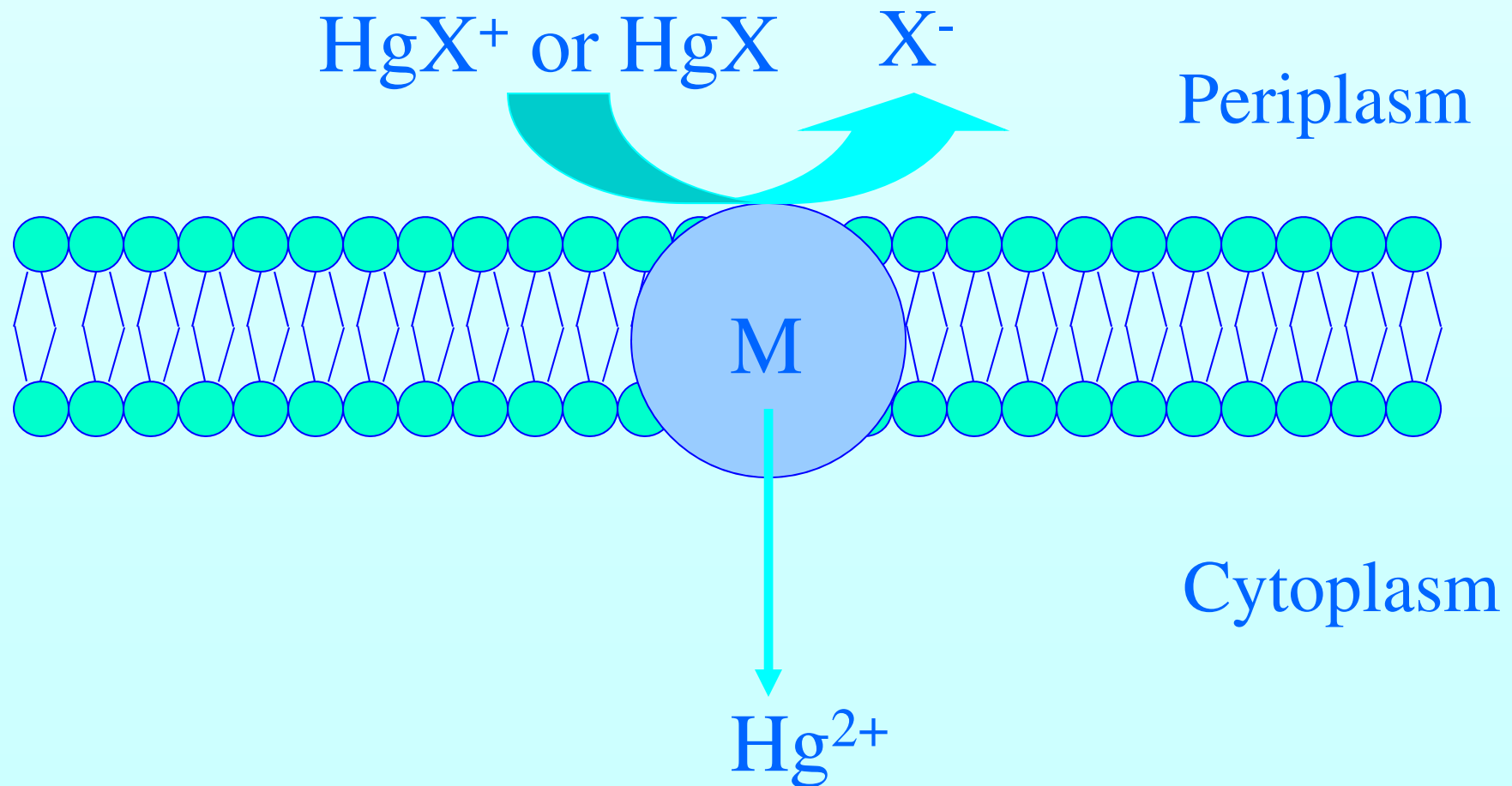
Periplasm

HgX^0

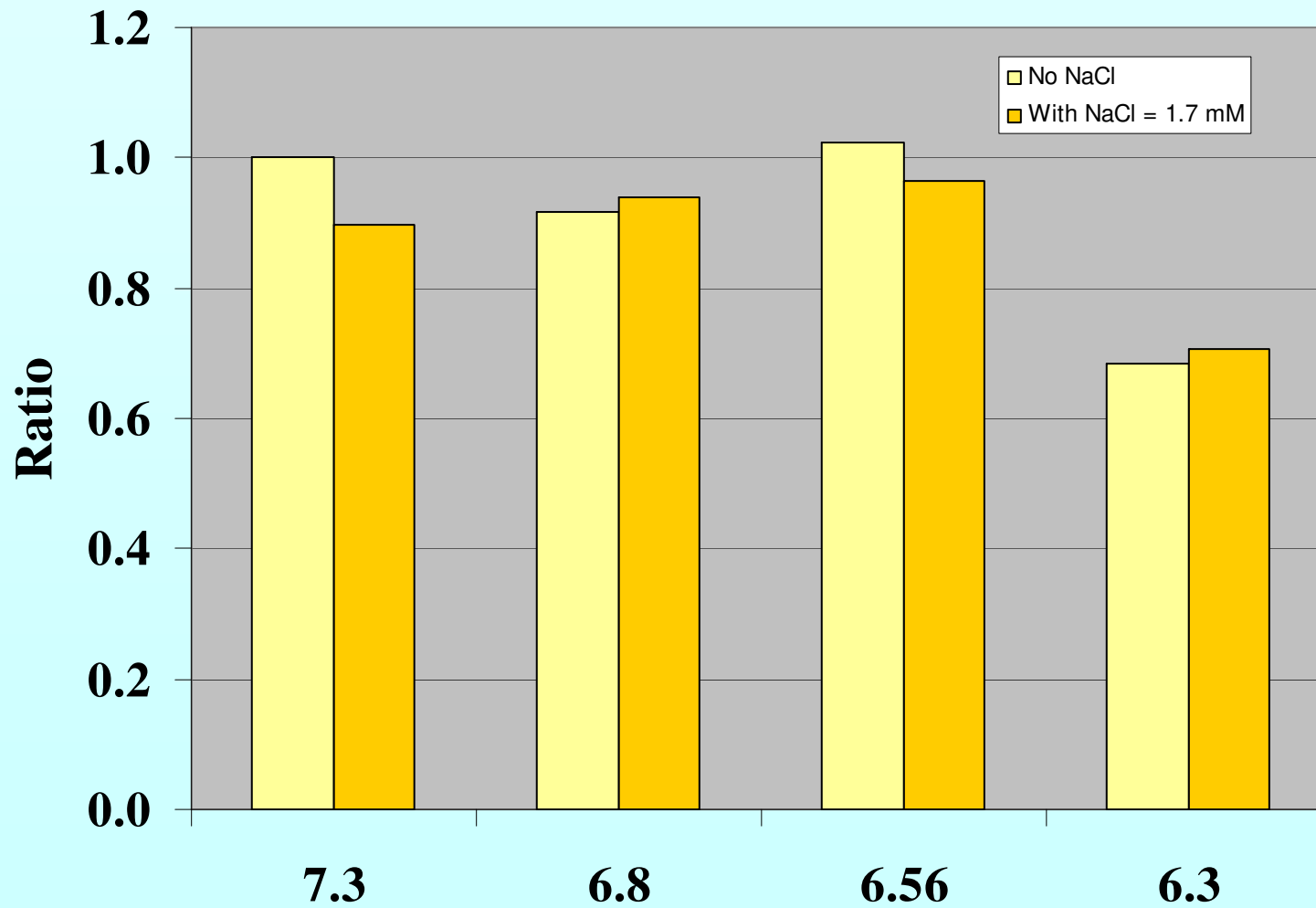
Cytoplasm



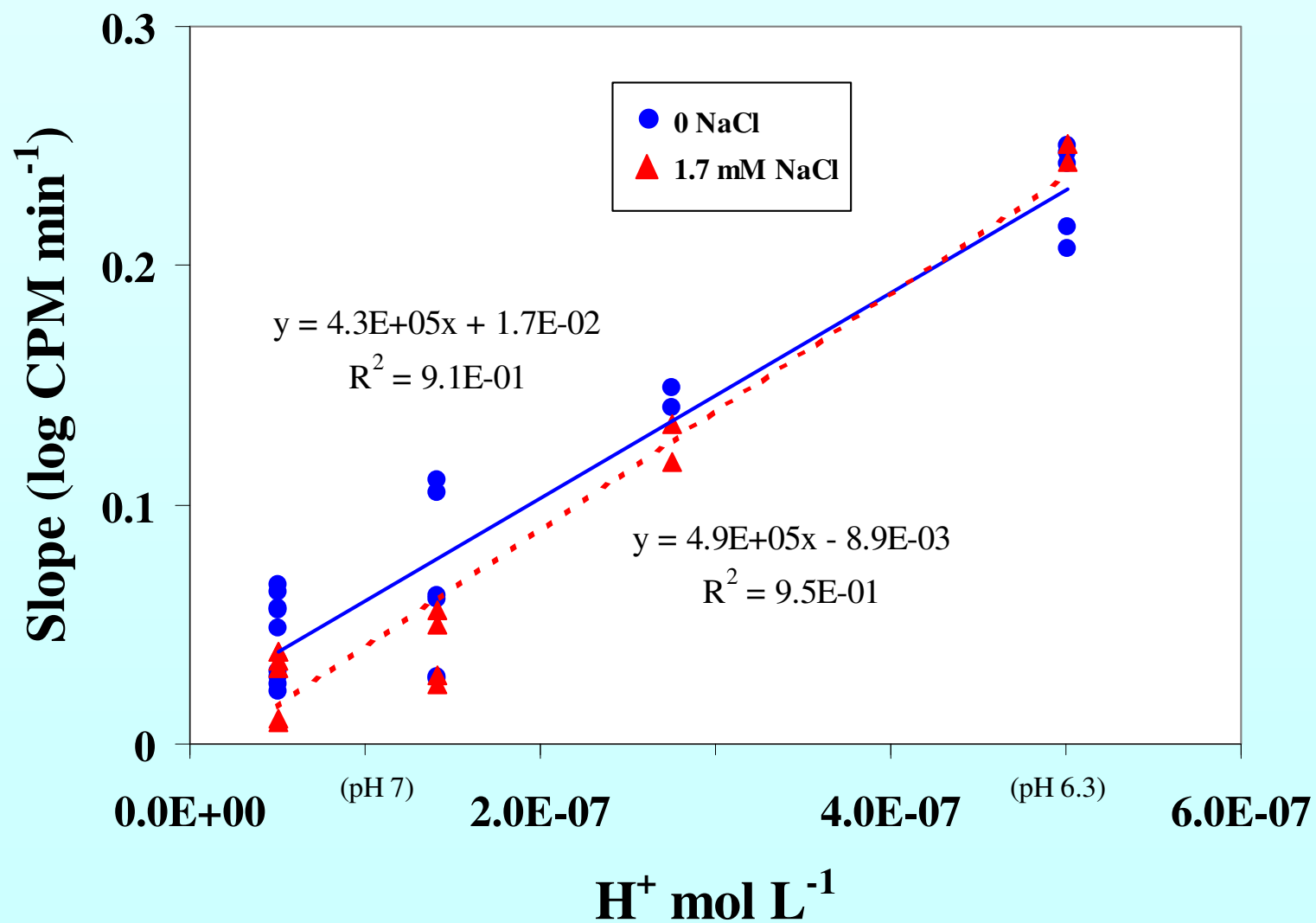
Facilitated Uptake

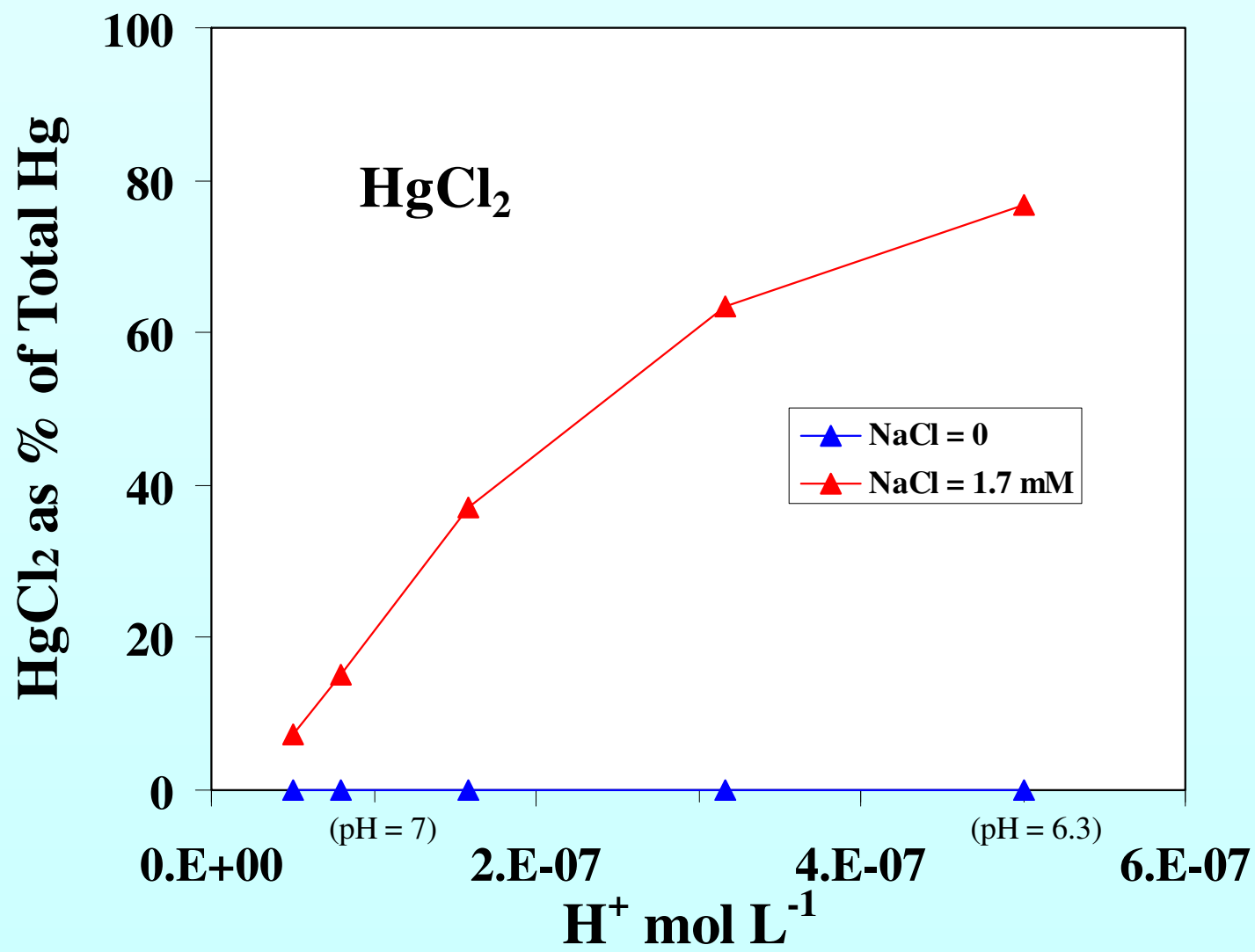


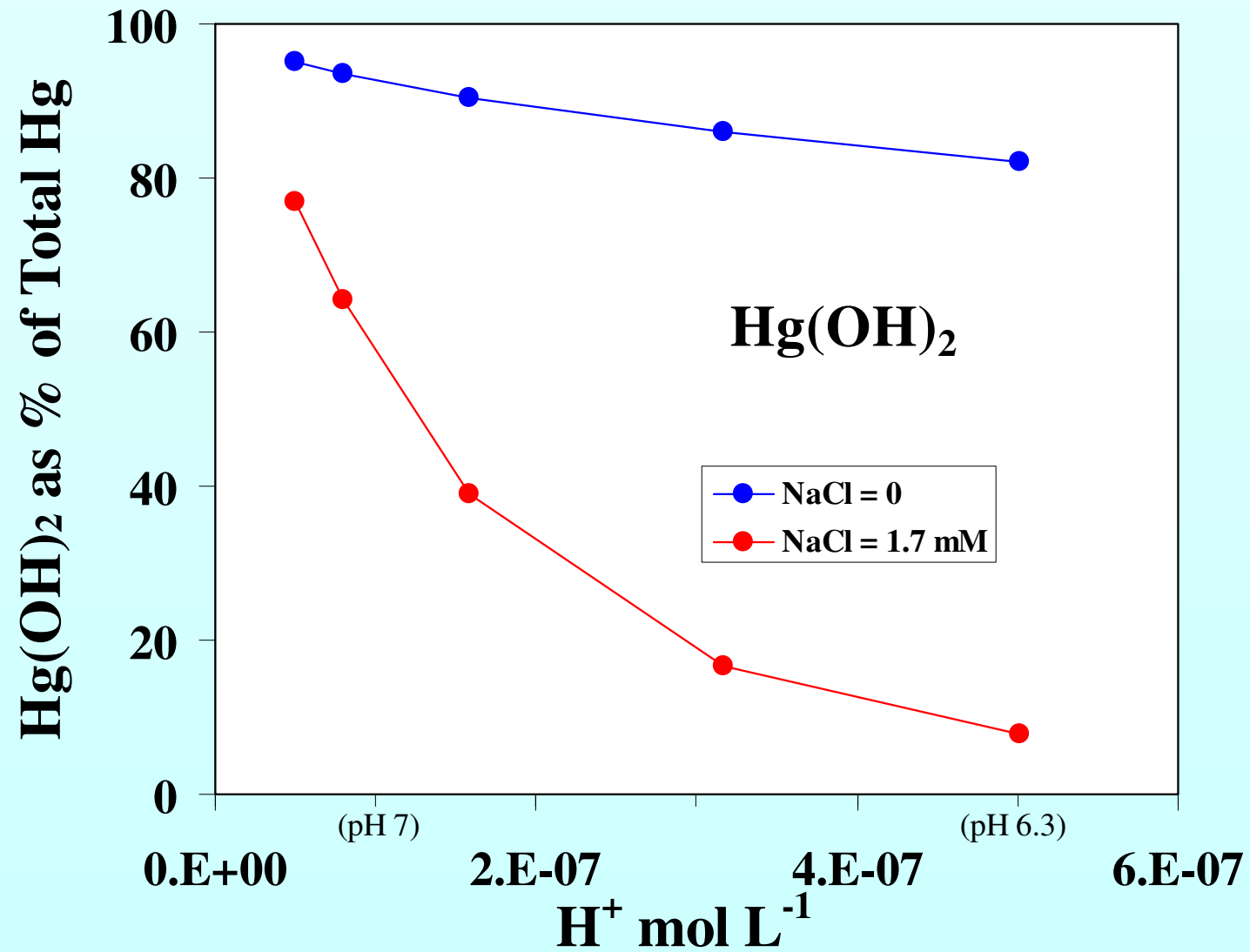
Effect of pH on Light production (Constitutive *lux* strain)



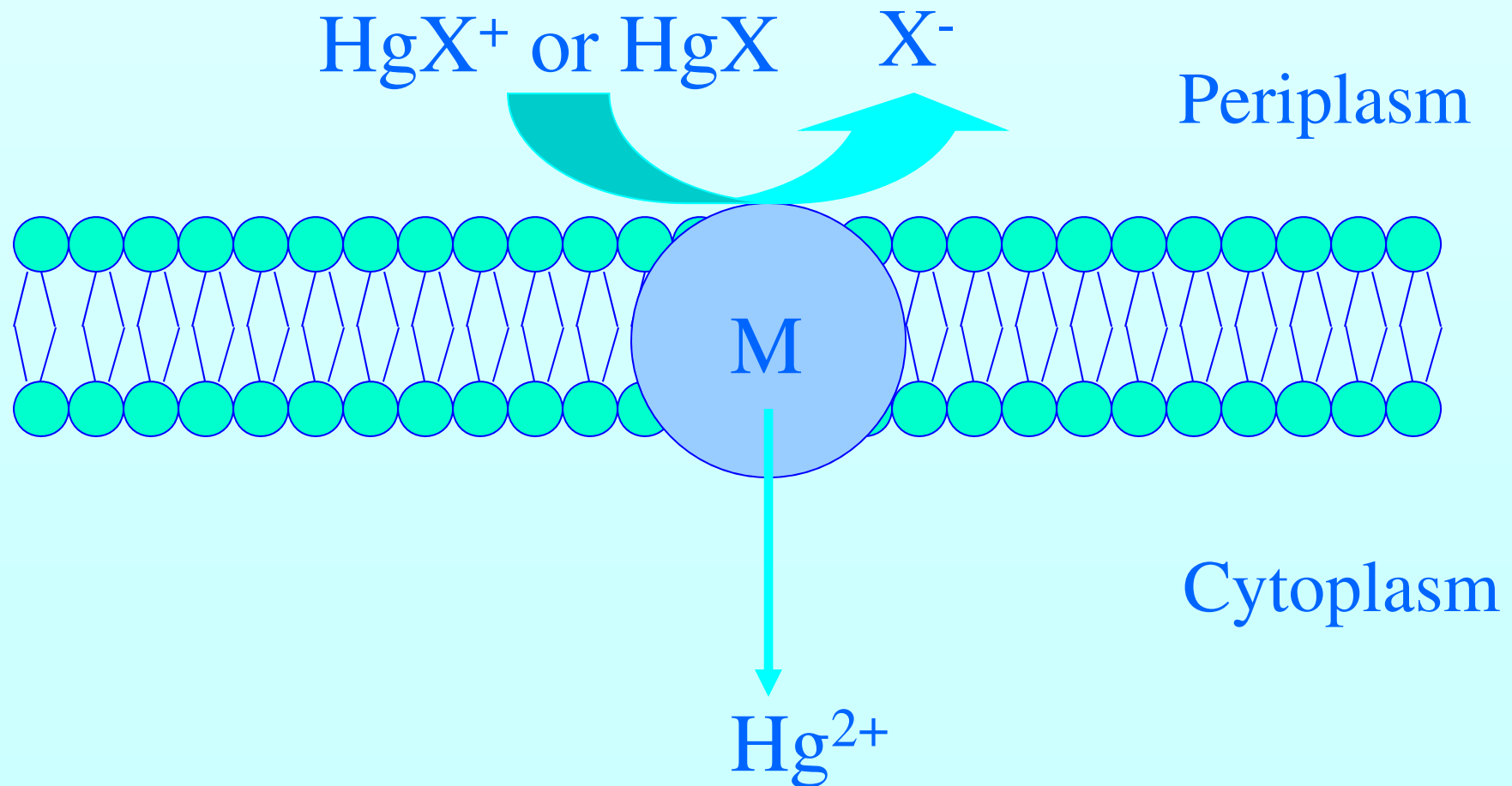
All assays 1 ng Hg/L







Facilitated Uptake



All samples 2 ng Hg L⁻¹

Response with no DOC = 100%

pH	Response with 85 $\mu\text{mol C L}^{-1}$ added as DOC
7.3	29 %
6.84	43 %
6.53	77 %

Hg additions to L. 658 water

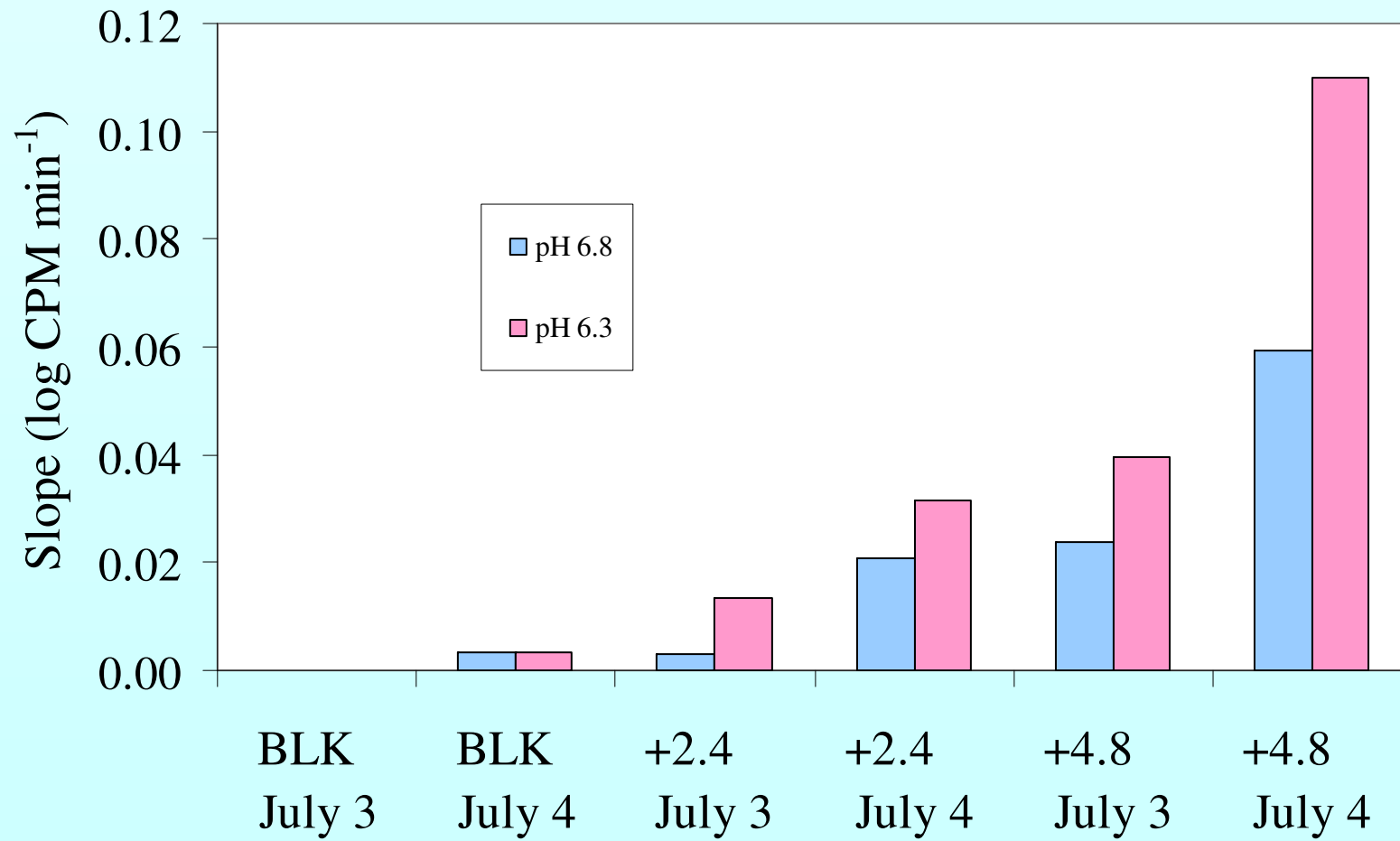
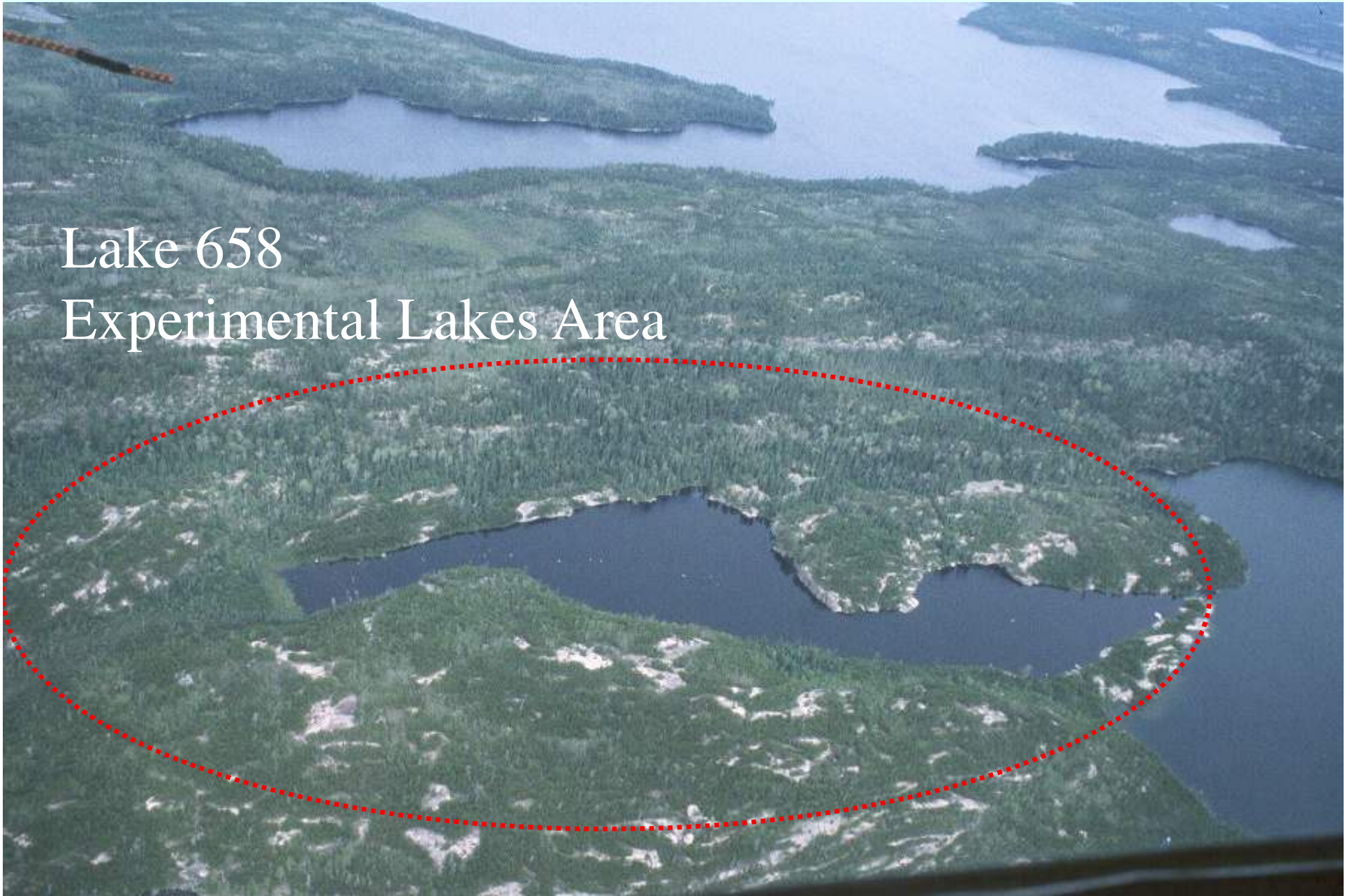


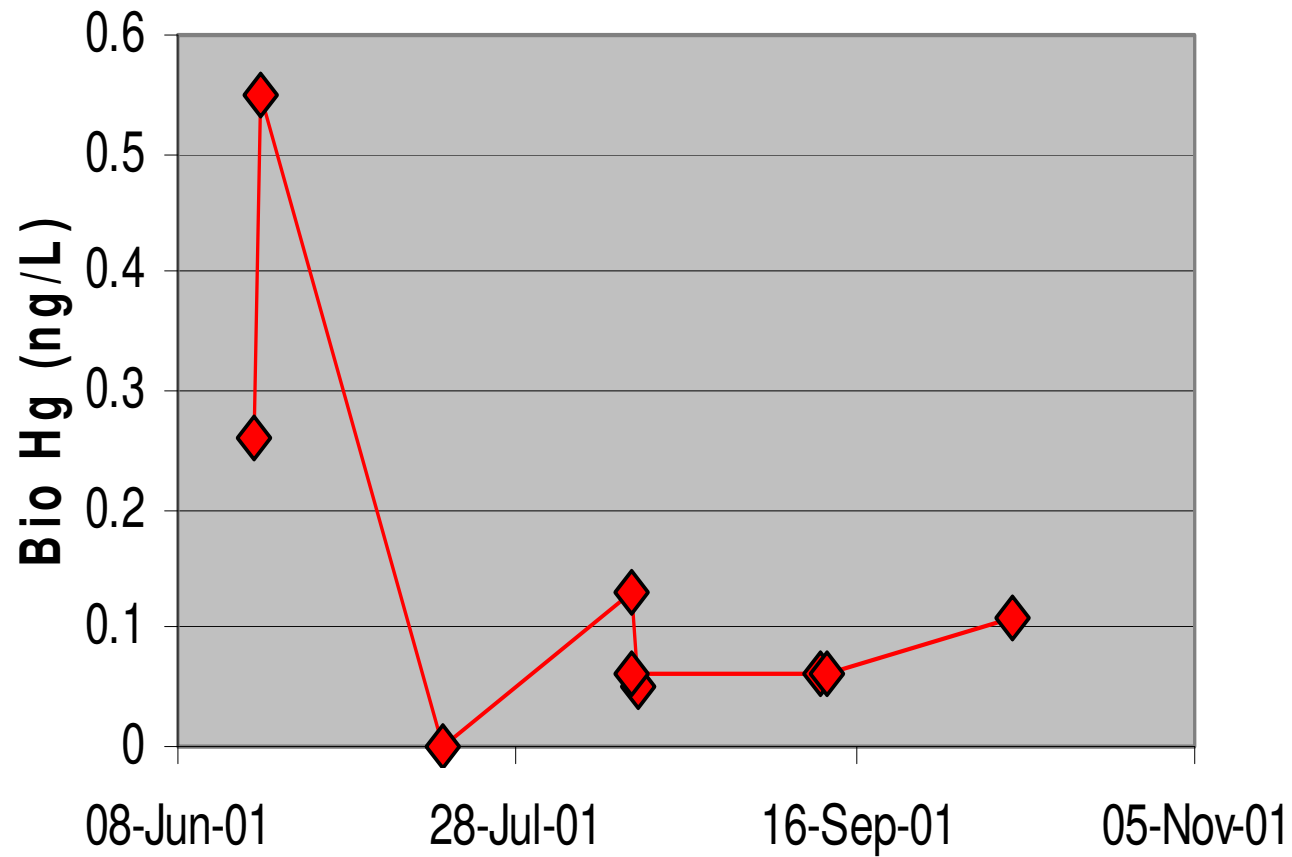
Figure 4

Study of bioavailability of Hg in natural waters

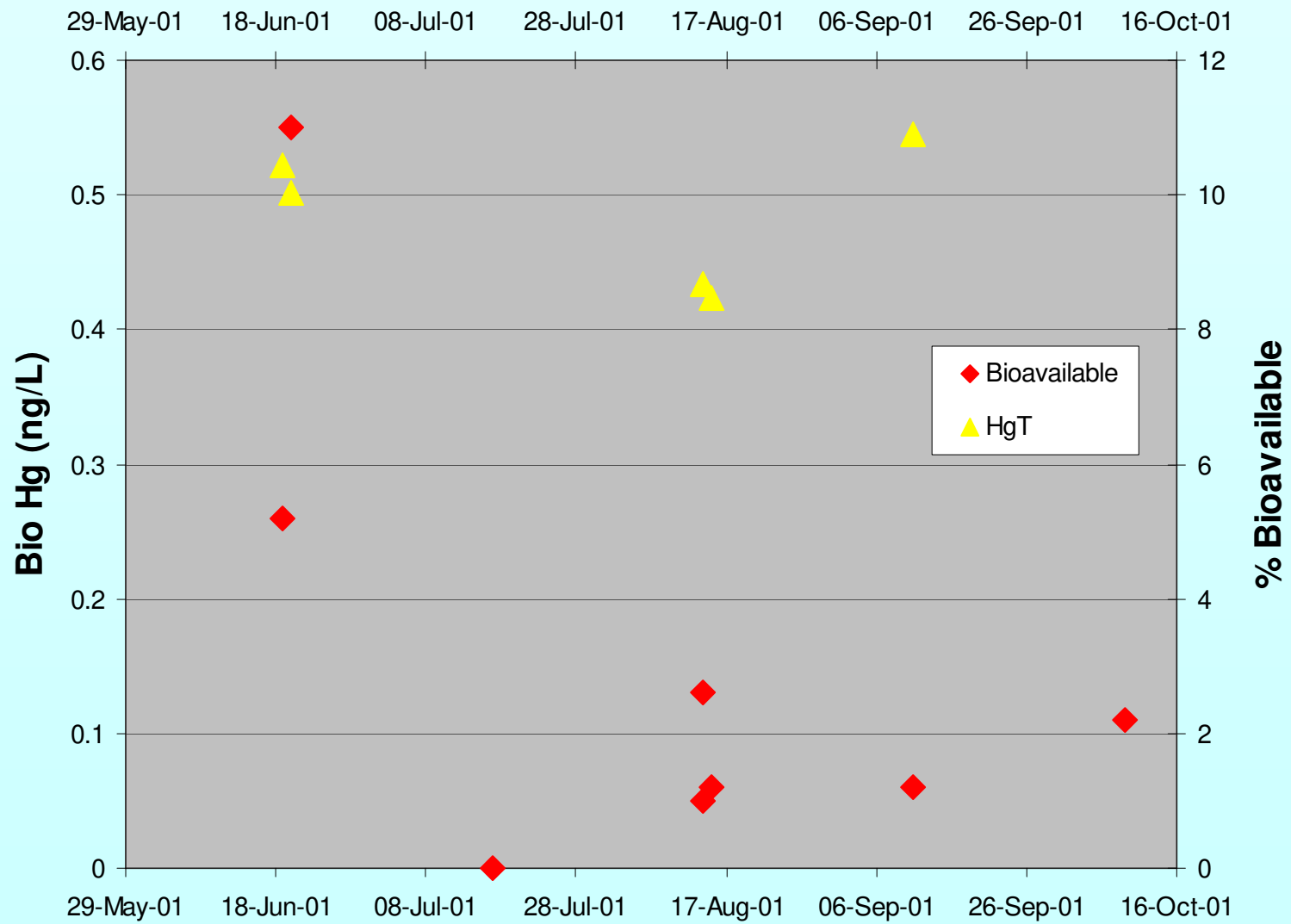
Lake 658
Experimental Lakes Area



Concentration of Bioavailable Hg in stream water



Stream Water



L. 658 Stream and Lake surface
July-Oct. 2001

	rain water	stream water	Lake 658
Bioavailable Hg(II), ng/L	0.22	0.06	ND
Total Hg ng/L	10.0	8-10	1.8-3
% Bioavailable	2.2	0.67	ND
pH	6.0	5.5	6.8
DOC (umol/L)	<100	1500	750

Conclusions

- Hg(II) uptake by these bacteria is facilitated, i.e., not by diffusion of neutral species
- “Bioavailable” Hg(II) has two components 1) the concentration of available chemical species and 2) the rate of the *bacterial* uptake process itself

☐ Important parameters in determining bioavailability of Hg in natural waters are [DOC], pH and [THg]

These results may explain why:

- At lower pH, methylation is higher in surface sediments (Xun et al. 1987) and in DOC amended lake water (Miskimmin et al. 1992)
- Fish MeHg is higher in lakes with lower pH (Wiener et al. 2002)

Assay Components

Vibrio anguillarum pRB28 Cells
(10^5 cells/mL)

5 mM glucose

0.09 mM $(\text{NH}_4)_2\text{SO}_4$

6.7 mM Phosphate buffer

Water:

Milli-Q

Milli-Q + $\text{Hg}(\text{NO}_3)_2$

Milli-Q + $\text{Hg}(\text{NO}_3)_2$ + NaCl

Milli-Q + DOC + Hg

Whole Lake water + Hg