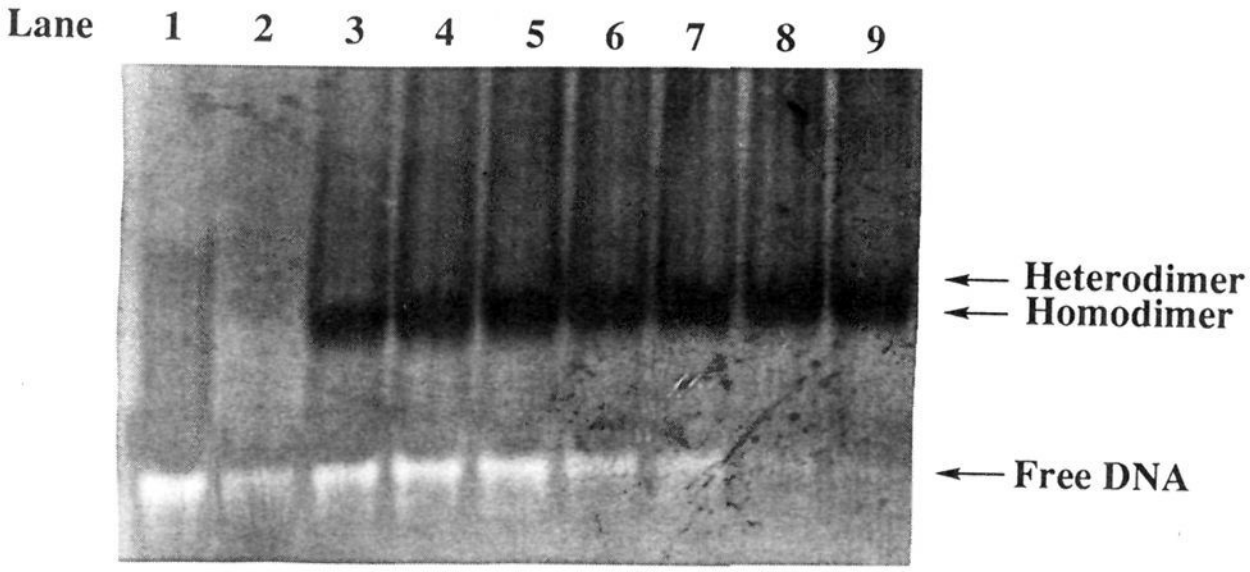
# *Additions and Corrections*

**Basic−Helix−Loop−Helix Region of Tal: Evaluation of Structure and DNA Affinity** [*J. Am. Chem. Soc.* **1995**, *117*, 8283−8284]. PATRICIA BISHOP, INDRANEEL GHOSH, CORY JONES, AND JEAN CHMIELEWSKI*

Page 8284: Figure 3 did not print well and has been reproduced below.



# *Book Reviews*

**The Theory of Chemostat: Dynamics of Microbial Competition.** Edited by Hal L. Smith (Arizona State University) and Paul Waltman (Emory University). Cambridge University Press: New York. 1995. xvi + 312 pp. $59.95. ISBN 0-521-47027-7.

The decision a 26 year old man made in 1936 on whether to spend a year at the California Institute of Technology or ship out on the research vessel, Pourquoi Pas, helps set the stage for this book's subject. The man was Jaques Monod. His decision to not join the Pourquoi Pas expedition turned out to be a good one for two reasons. First, the Pourquoi Pas sank along the Greenland coast with all hands lost. Secondly, he gained the experience he needed to grow and broaden scientifically which ultimately culminated in his thesis, Recherches sur le croissance des cultures bacteriennes.

Monod's thesis defined microbial growth rate and yield and determined the dependence of growth rate on limiting nutrient (e.g., glucose) concentration. Later, in 1950, Monod independently developed the principle of continuous growth and designed a reactor for elucidating microbial growth kinetics. A fixed volume, well-mixed vessel was provided with a constant in-flow of limiting nutrient while the cells and residual nutrient in the vessel were removed at the same flow rate. Eventually, a steady state (cell growth balances removal rate) could be established, thereby allowing the relationship between sustained cellular growth rate and time-invariant (residual) nutrient concentration to be determined. The relationship he found, now often referred to as the "Monod Model", proved to be a hyperbolic dependence on nutrient concentration akin to enzyme kinetics.

The growth vessel he referred to as the "bactogene" is now commonly referred to as the "chemostat". The chemostat has become an omnipresent apparatus in ecology, microbiology, environmental engineering, and biochemical engineering laboratories. Most chemists and chemical engineers will recognize the chemostat as a variation of the continuous-flow stirred-tank reactor, but with additional constraints. For those who work with microbes, the ability to manage growth conditions and observe the time-dependent behavior of microbes or population constituents allows for physiological, kinetic, and interspecies competition information to be gleaned. Alternately, chemostat experiments provide a means for testing theories or models.

The literature on using the chemostat as a research, production, and model system as well as analyzing the data it provides is widely distributed in biomathematics, ecology, and engineering journals. The different communities utilizing the chemostat and attendant scattering of literature have arisen, in part, due to the different problem statements each community focuses on. For example, an engineer is interested in yield maximization in the "production reactor" whereas stability in a "simple lake model" may be of more concern to some ecologists or microbiologists. However, when viewed with a broader lens, some overlap also exists. For example, a "contamination problem" to a biochemical engineer is equivalent to an ecologist's "competition problem".

Because many communities extensively utilize the chemostat, and as is often the case, interfield communication can benefit from facilitation, the authors have attempted to collect, unify, and synthesize the literature on chemostat theory and microbial dynamics. The framework and language is the mathematics of differential equations and nonlinear systems. Additionally, they have sought to resolve some questions on the generality of some concepts such as competitive exclusion (when one microbe out competes another for a single resource).

The reader will find the book organized much like the way one would study an ecosystem. A chapter will define and investigate a simplified situation. The following chapters then introduce additional factors or relationships to the analysis to see how the prior conclusions hold up. For example, the first chapter, The Simple Chemostat, deals with steady states and competition between two microbes where the simple (Monod) hyperbolic relationship between growth rate and nutrient availability applies. The aim is to arrive at competitive exclusion criteria. The next chapter explores the validity of the ideas deduced from the simpler description, but now assuming that alternative relationships between growth and nutrient availability are operative. The following eight chapters address expansions such as adding a predator to the system (add trophic levels), allowing for spatial nonuniformity, and periodic inputs. The book concludes with New Directions, which include the biotechnical problem of competition between plasmid-free and plasmid-bearing microbes. Finally, six Appendices harbor mathematical details and supplementary background. Within each chapter, there is mathematical development, referral to data when available, and a discussion that boils things down or shows how uncertainties on some problems are or are not resolved. Nomenclature and coaching the reader as to