natural distribution and 180 man-distributed (weeds and cultivated plants).

The introductory chapters are replete with information regarding the islands, climate, topography, plant formations, history of botanical exploration, origin and affinities of the flora, etc. As noted by the author, S. Tomé was uninhabited when it was discovered by the Portuguese in 1470–71, and thus it has been possible to make some pertinent observations on the effect of man on the natural vegetation within a known period. By transfer seventy-five new names are published, and thirty-five new species are described, the new names being largely due to the critical bibliographic and herbarium work of the author and his associates. *Aidia* Lour. 1790 is reinstated as a valid genus, type *Aidia cochinchinensis* Lour. (*Randia cochinchinensis* Merr.; *Randia densiflora* Benth.), the group hitherto having been included in *Randia* Linn.

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CHEMICAL MACHINERY

Chemical Machinery. An Elementary Treatise on Equipment for the Process Industries. By EMIL R. RIEGEL. vii + 583 pages. New York: Reinhold Publishing Corporation. 1944. $5.00.

IN its twenty-seven chapters this volume covers some twenty-three general types of process equipment. Also included is a three-chapter section on instruments for measuring and controlling temperature, pressure, flow and other process variables. The coverage of general types of equipment, *i.e.*, agitators, heat exchangers, filters, crystallizers, evaporators, etc., is quite complete. The book is well illustrated by the 436 photographs and line drawings which it contains. The material presented is up to date and the inclusion of cost figures with corresponding dates will be valuable in the preparation of rough cost estimates. References are included at the end of each chapter which will prove helpful to any one interested in a detailed discussion, particularly of the theoretical aspects, of the design of equipment. Theoretical discussions are almost entirely lacking and those few included are most elementary and incomplete.

This book will be helpful to any one interested in acquainting himself with the various kinds of equipment available for carrying out such operations as drying, size reduction, distillation, pumping, etc. It will enable him also to get some idea of the size and capacity, as well as the cost, of process equipment as used on a production scale. As a general descriptive survey of the process equipment field it fills a certain need in the literature of chemical engineering.

There is a tendency in the book toward lack of precision of statement which makes the presentation sometimes confusing and occasionally misleading. Technical terms are often introduced without definition and many unwarranted generalizations are made. Read with some background of training or experience in chemical engineering these difficulties are not serious.

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SPECIAL ARTICLES

RELATION OF THE STREPTOCOCCUS LACTIS R FACTOR TO "FOLIC ACID"

RECENTLY, the isolation of a growth factor for *Streptococcus lactis* R (SLR factor) was reported, which effectively replaces "folic acid" in the nutrition of this organism but is inactive for *Lactobacillus casei*.[1]

It has since been found that folic acid[2] is formed when *S. lactis* R is grown in a folic acid-free medium containing the SLR factor. The presence of folic acid in such cultures is shown by the fact that the whole culture, the cells or the culture fluid, when added in adequate amounts to folic acid-free media, support maximum growth and fermentation of *L. casei* and other folic acid requiring lactic acid bacteria. Table 1 gives results obtained with the supernatant fluid of a centrifuged culture of *S. lactis* grown for 1 day in media containing the SLR factor.

It is evident that the *S. lactis* R factor, although present in a concentration 100 times that required for optimum growth of *S. lactis*, can not replace folic acid for the lactobacilli. However, growth of *S. lactis* in a medium containing the SLR factor results in the formation of sufficient folic acid per cc to permit acid formation by the lactobacilli equal to or greater than that obtained with 0.003γ units of folic acid.

It is possible that the SLR factor stimulates *S. lactis* to synthesize folic acid from the other constituents of the medium. However, it seems more likely that the SLR factor, *per se*, is transformed into folic acid since the amount of folic acid formed increases as the quantity of SLR factor in the medium is raised even considerably beyond that required for maximum growth of the organism. Moreover, folic

[1] J. C. Keresztesy, E. R. Rickes and J. L. Stokes, SCIENCE, 97: 465, 1943.

[2] The term "folic acid" is used because activity was compared to that of a folic acid concentrate kindly supplied by Dr. R. J. Williams. However, the term is used in this paper to include any substance which can replace folic acid in the growth of *L. casei*. *Cf.* E. E. Snell and W. H. Peterson, *Jour. Bact.*, 39: 273, 1940; J. J. Pfiffner *et al.*, SCIENCE, 97: 404, 1943; R. L. R. Stokstad, *Jour. Biol. Chem.*, 149: 573, 1943; B. L. Hutchings *et al.*, SCIENCE, 99: 371, 1944.

TABLE 1

ACID FORMATION BY "FOLIC ACID" REQUIRING LACTOBACILLI IN VARIOUS GROWTH FACTOR MEDIA

Organism	Addenda to 10 cc of basal medium*			
	Nil	SLR factor 0.3γ units†	"Folic acid" 0.003γ units†	1 cc culture fluid of *S. lactis* R grown with 0.3γ units of SLR factor per 10 cc of medium
	cc. N/10 acid formed in 3 days at 37°			
Lactobacillus casei	1.1	0.8	6.5	7.0
Lactobacillus delbrückii LD5	1.9	1.6	7.7	8.7
Lactobacillus casei 19	1.0	0.9	2.5	2.4
Lactobacillus bulgaricus 05	1.8	1.4	7.4	8.5

* Essentially as described by Landy and Dicken, *Jour. Lab. Clin. Med.*, 27: 1086, 1942.

† Using *S. lactis* R, the activity of the SLR factor was standardized against a folic acid concentrate. One "microgram unit" is equivalent to one microgram of folic acid of "potency 40,000." For definition of the latter see H. K. Mitchell and E. R. Snell, *University of Texas Publication* No. 4137, 36, 1941. One microgram of factor SLR is equivalent to approximately 5γ units of folic acid.

acid can be readily produced by adding washed cells of *S. lactis* to a water solution of the SLR factor and incubating the mixture for 3 to 4 hours at 30° C. Under such conditions cell growth is largely eliminated.

A survey of factor SLR and folic acid requirements of a number of lactic acid bacteria revealed that *Streptococcus fecalis* 732, *Streptococcus fecalis* F24, *Streptococcus zymogenes* 5C1 and *Streptococcus durans* 98A, also, can develop with either the SLR factor or folic acid (Table 2). Growth of these strep-

TABLE 2

STREPTOCOCCUS LACTIS R FACTOR AND FOLIC ACID REQUIREMENTS OF LACTIC ACID BACTERIA

Organisms requiring		
Factor SLR or folic acid (interchangeable)	Folic acid	Nil
Streptococcus lactis R	*Lactobacillus casei*	*Lactobacillus arabinosus* 17–5
Streptococcus fecalis 732*	*Lactobacillus delbrückii* LD5	*Leuconostoc mesenteroides* 6205†
Streptococcus fecalis F24*	*Lactobacillus bulgaricus* 05	*Streptococcus lactis* 374† [illegible] L103* L104* L206*
Streptococcus zymogenes 5C1*	*Lactobacillus casei* 19	*Streptococcus fecalis* 10C1
Streptococcus durans 98A*	*Streptococcus fecalis* S108A*	*Streptococcus zymogenes* 6054†

* We are greatly indebted to Dr. J. M. Sherman of Cornell University for these cultures. Their folic acid requirements have been determined by Dr. Sherman (personal communication) and our results confirm those obtained by him.

† Obtained from the American Type Culture Collection.

tococci in SLR factor medium is accompanied, in every case, by formation of folic acid. Some lactic acid bacteria, primarily lactobacilli, can not utilize the SLR factor and must be supplied with folic acid for growth. However, the majority of the strains examined do not require either factor for growth, presumably because they are able to synthesize folic acid. Synthesis of folic acid was established for *Lactobacillus arabinosus, Leuconostoc mesenteroides* and *Streptococcus fecalis* 10C1.[3]

As indicated in Table 2, folic acid can replace the SLR factor for all bacteria which can utilize the latter. Also, in every instance folic acid is formed when such organisms are grown with the SLR factor. It, therefore, seems probable that the latter is biologically active because it can be converted to folic acid. If this is the case, the rate of conversion of factor SLR to folic acid must be very rapid, since the rate of growth of *S. lactis* R in media containing these factors is essentially the same[4] (Fig. 1).

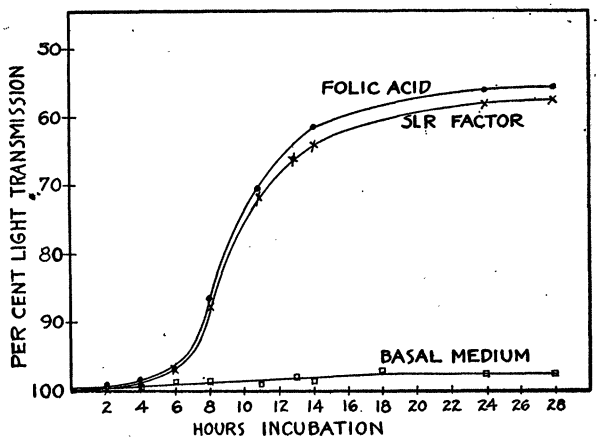

FIG. 1. Rate of growth of *Streptococcus lactis* R in SLR factor and "folic acid" media.

The *S. lactis* R factor, unlike xanthopterin, does not give rise to folic acid when incubated with rat liver suspensions.[5,6]

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THE EFFECT OF ATROPINE SULFATE ON THE COURSE OF INFLUENZA VIRUS INFECTION[1]

IN an investigation of the influence of various factors on the resistance of experimental animals to in-

[3] *Cf.* B. L. Hutchings, N. Bohonos and W. H. Peterson, *Jour. Biol. Chem.*, 141: 521, 1941.

[4] 0.015γ units of each growth factor per 10 cc of medium was used. The cultures were incubated at 30° and growth was measured in an Evelyn photoelectric colorimeter.

[5] L. D. Wright and A. D. Welch, SCIENCE, 98: 179, 1943. An increase in folic acid was obtained with xanthopterin which confirms the results of Wright and Welch.

[6] We are indebted to Miss Marion Gunness and Mrs. Alma Larsen for capable assistance, and Messrs. E. L. Rickes and L. Chaiet for the preparation of the *Streptococcus lactis* R factor.

[1] This work was aided by a grant from the Kresge Foundation.