Tabelle I

Bakterienstämme	Chemotaktische Wirkung lebender Bakterien auf Plasmanährboden	Chemotaktische Wirkung gewaschener, erhitzter Bakterien (Bouillonkultur)	Auswanderungswirkung durch Suspension gewaschener, erhitzter Bakterien	Auswanderungswirkung von Kulturlösung 1:1000	1:10000	1:100000	1:1000000
Bouillon, unbeimpft				ø			
Staphylococus aureus Nr. 3	+	ø	ø	ø	ø	ø	ø
Staphylococus albus Nr. 4	+	ø	ø	ø	ø	ø	ø
Diplococus sp. Nr. 102	+	ø	ø	ø	ø	ø	ø
Streptococus faecal Nr. 57	+	ø	ø	ø	ø	ø	ø
Streptococus pyog. Nr. 36	+	ø	ø	ø	ø	ø	ø
Coryneb. dipht. Nr. 161	+	+	+	ø	ø	ø	ø
Sarc. lutea Nr. 124	ø	ø	ø	ø	ø	ø	ø
Sarc. alb. Nr. 121	ø	ø	ø	ø	ø	ø	ø
Proteus vulg. 0 X 19	+	+	+	+ + +	+ + (+)	+ +	ø
Escherichia coli Nr. 201	+	+	+	+ +	+	+	ø
S. marcescens Nr. 261	+	+	+	+ + +	+ + +	+ +	+
Klebsiella, Typ A Nr. 327	+	+	+	+ + +	+ + +	(+)	ø
Cholerae el Tor Nr. 361	+	+	+	+ +	+	ø	ø

+ = Chemotaxis oder Förderung der Auswanderung ø = keine Wirkung

Tabelle II

	Aus 1 cm³ Kulturfiltrat wurden gefällt in mg Substanz	Konzentrationen, bezogen auf das Ausgangsfiltrat pur	1:10	1:100	1:1000	1:10000	1:100000	1:1000000
Proteus vulg. 0 X 19 (2)				+ + +	+ + +	+ + (+)	+ + (+)	
Proteus vulg. (2), erhitzt				+ + +	+ + +	+ + (+)	+ +	
Proteus vulg. 0 X 19 (4)		+	+ + +	+ + +	+ + +	+ + +		
Benzoesäurefällung aus (2)	1,05	+ +	+ + +	+ + +	+ + +	+ +	+ +	+
Lyophilgetrocknetes Filtrat (2)	23,0	– – –	+ +	+ + +	+ + +			
Pikrinsäurefällung aus (4)	1,6	+ + +	+	(+)	ø	ø	ø	
Ammonsulfatfällung aus (4)	6,0	+ +	+ +	ø	ø	ø	ø	
Alkoholfällung aus (4)	5,5	+ + +	+ + +	+ + +	+ + +	+ + +	+ +	(+)
Nährboden, steril filtriert, unbeimpft		–	ø	ø	ø	ø		
Benzoesäurefällung des unbeimpften Nährbodens		(+)	(+)	ø	ø			
Lyophylgetrockneter Bouillonboden		–	ø	ø	ø	ø		

— = Hemmung der Auswanderung + = Forderung der Auswanderung ø = Keine Wirkung

jedoch vor allem gramnegative Keime thermostabile Stoffe in nachweisbaren Mengen. Diese thermostabilen Chemotaxine sind sowohl in gewaschenen Bakterien als auch in den Kulturfiltraten vorhanden. Aus den Anreicherungsmethoden sowie aus dem Verhalten bei Hitzebehandlung und Dialysieren kann gefolgert werden, dass die Wirksamkeit an Stoffe von polysaccharidartiger Natur gebunden sein muss[1].

Über den Einfluss des Nährbodens auf die Produktion dieser Chemotaxine sowie über die Natur dieser Stoffe aus grampositiven und gramnegativen Keimen sind weitere Arbeiten im Gange.

R. MEIER und B. SCHÄR

Wissenschaftliche Laboratorien der Ciba Aktiengesellschaft, Basel, den 10. Januar 1953.

[1] Vgl. dazu J. L. BENNNETT und P. B. BEESON, Medicine *29*, 365 (1950).

Summary

The majority of the bacteria investigated, in the living state exhibited leukotaxis *in vitro*; it is, however, mainly the gramnegative organisms and their culture-filtrates which contain active substances, probably of a polysaccharide-like nature, in readily demonstrable quantities.

The Influence of Light upon Germination

The effect of light on the germination of seeds has been known for a long time[1]. Certain varieties of freshly harvested lettuce seeds, for instance, germinate fully only when exposed to light. Although the biological process of germination is evidently a complicated one, addi-

[1] Cf. M. EVENARI in *Radiation Biology* (McGrawHill & Co., New York) (in the press).

tional evidence has recently become available which enables one to interpret the mechanism of certain steps in light-germination in some well defined cases.

Recently HENDRICKS and coworkers[1] have shown that light between the wavelengths of 5250 and 7000 Å promotes germination whilst radiation in the region of 7000 to 8200 Å reverses this effect. The maximum of promotion occurs at about 6600 Å, the maximum of inhibition at about 7300 Å.

The temperature at which germination is carried out has a profound influence on light germination. Thus lettuce seeds, var. Grand Rapids, germinate at 14°C with the same high percentage in light and darkness. With rising temperature, germination becomes more and more inhibited in darkness. This inhibition is overcome by light. The maximum of this light sensitivity is reached at 26°C. At higher temperatures germination decreases in light and in darkness, so that the germination-promoting influence of light is more reduced. At last at 31°C the seeds are heat-dormant[2].

Furthermore, it is known that the promoting effect of light can be replaced under certain conditions by the admission of oxygen[3] or relatively much higher pressure of carbon dioxide[4] into the seeds. There are also certain chemicals known (thiourea[5], coumarin[6]) which can promote or repress germination in conjunction with the effect of light.

These observations are in agreement with the assumption that the fundamental process involved in the induction of germination consists of an electron transfer from a dye, A, which has an absorption peak in the neighbourhood of 6600 Å. The absorption of the appropriate quantum causes the formation of an excited molecule

$$A + h\nu_1 \rightarrow A^* \qquad (1)$$

which, instead of returning to its original state, may lose its excited electron to a neighbouring trap,

$$A^* \rightarrow A^+ + e_{tr} \qquad (2)$$

with the formation of an odd ion. This trap may consist of a potential well, which is formed from a metastable state of the original system in conjunction with the surrounding dielectric medium.

The absorption peak of the new system involving the trapped electron will be shifted to approx. 7300 Å. Absorption of a quantum of suitable energy may cause the release of the electron from its trap and recombination

$$A^+ + e_{tr} + h\nu_2 \rightarrow A. \qquad (3)$$

Similarly an increase in temperature may supply the required energy of activation for liberating the electron from the potential well. The energy requirements of the two types of back reaction need not be identical[7].

Oxygen would react with the original dye molecule with total or partial electron transfer[8]

$$A + O_2 \rightarrow A^+ \cdots {}^-O_2. \qquad (4)$$

In these schemes the important role for the germination process would be played by the odd ion A^+, which could initiate the germination process either in that form, or, after a process of hydration, through its associated free radical, B, where

$$B + H^+ \rightleftarrows A^+. \qquad (5)$$

Similar interpretations have been applied recently to experiments regarding the influence of infrared irradiation and heat on the frequency of mutation induced in certain cases by ultraviolet or ionizing radiations[1]. The effects observed in those cases appeared also compatible with the assumption of the transient formation of trapped electrons in biological systems, and their release from the traps by light or heat.

It was shown recently that oxygen molecules or much higher concentrations of carbon dioxide may serve as electron acceptors[2] in systems consisting of dilute solutions of organic dyes in gels or in organic plasctics[3]. In this case, as also in ionic crystals, as the results of the action of ionizing radiations, some of the ejected electrons may become trapped in the system and a new absorption band appears at a wavelength longer than that of the original dye.

The electrons may be released again and recombination promoted either by re-irradiation with light of the appropriate longer wavelength or thermally. In ionic crystals the activation energy of the thermal back reaction has been found to be of the order of 0·16–0·3 eV, or say 3·5–6·5 kcal[4]. Closely related also is the formation of similar trapped electrons in some semi-conducting systems[5]. Both the wavelenghth promoting the back reaction and the thermal activation energies required are similar in the physical and biological systems. It seems that at least in certain well defined aspects the influence of light upon germination shows regularities which can be best interpreted on the assumption that, in the process of germination, an electron transfer is involved at one stage which involves the reversible trapping of electrons in the biological system.

M. EVENARI and G. STEIN

Department of Plant Physiology and Department of Physical Chemistry, Hebrew University, Jerusalem, October 7, 1952.

Zusammenfassung

Es wird der Versuch gemacht, den Einfluss des Lichtes auf die Samenkeimung (zum Beispiel Salatsamen, var. Grand Rapids) auf einen physikochemischen Mechanismus zurückzuführen. Dieser besteht darin, dass Elektronen in metastabilen Zuständen in Elektronenfallen festgehalten werden. Diese Auffassung wird dadurch gestützt, dass der Einfluss von Licht verschiedener Wellenlängen, verschiedener Temperaturen und verschiedener Sauerstoffkonzentrationen auf die Samenkeimung und auf bestimmte physiko-chemische Prozesse, die auf dem oben erwähnten Elektronenmechanismus beruhen, ähnlich ist.

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[4] E. E. SCHNEIDER, in *Fundamental Mechanisms of Photographic Sensitivity* (Butterworth, London, 1951), p. 13.

[5] G. F. J. GARLICK, *Luminescent Materials* (Oxford University Press, 1949).