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(16) The Chemostat - An Apparatus for Quantitative Measurement of Spontaneous Mutations of Bacteria". Science (In Press).

(17) "Studies with the Chemostat on Spontaneous Mutations of Bacteria". Proceedings of National Academy of Sciences. (In Press).

Dr. Szilard's part in the bringing about of the first nuclear chain reaction; in the design of the first nuclear reactor (atomic pile) are described, insofar as these matters can be made public, in the Official Report: Atomic Energy for Military Purposes, Henry D. Smyth, 1945, Princeton University Press, Pages 34, 47, etc.

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BIOGRAPHICAL SKETCH - DR. LEO SZILARD

Born 1898, Budapest, Hungary

Ph. D. Physics 1922 University of Berlin, working with Von Laue

Scientific papers dealing with statistics and thermodynamics, 1922-1925

Privatdozent, University of Berlin, 1925-1933

Teaching of physics; scientific papers in experimental X-ray physics.

Research appointments in nuclear physics at Clarendon Laboratory, Oxford

University, Oxford, England, and at St. Bartholomew's Hospital 1934-1938

Discovery of Szilard-Chalmers reaction, 1938

Discovery of photo-disintegration of Beryllium, 1939

Discovery with Zinn of neutron emission in Uranium fission, 1939

Memorandum to U.S. Government first proposing a nuclear chain-reaction utilizing uranium with a graphite moderator, Oct. 1939

In 1939 Dr. Szilard organized the Uranium Committee, to interest the U.S. Government in atomic energy as a source of power, and in an atomic bomb. This committee, whose activities are described in detail in the Smyth report, persuaded the government to establish what eventually became the Manhattan Project. (Official Report: Atomic Energy for Military Purposes, Henry D. Smyth, 1945, Princeton University Press, Pages 34, 47, etc.)

Design of first nuclear pile for harnessing atomic energy - with Fermi, 1939-1940 (Smyth report, page 34)

Member of staff of Columbia University's National Defense Division, 1940-1942. Szilard and Fermi were in charge of all work on the Chain Reaction. (Smyth report, page 55)

Chief Physicist of University of Chicago Metallurgical Laboratory, Manhattan Project, which developed the first nuclear chain reaction, and built the first pile for production of radioisotopes, 1942-1946.

Professor of Biophysics, University of Chicago, 1946 to present. Dr. Szilard also holds a joint professorship in Social Science at the University of Chicago, in order to assist in studies of the social and political effects of atomic energy.

Investigations on mechanism by which cells killed by ultraviolet radiation can be revived by visible light; the physics of cellular mutation processes; and the mode of action of viruses, 1946-1949.

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This paper reports the discovery of neutron resonances at low energies, gives an estimate of their energies, and states that the energies can be measured by observing the absorption of the residual neutrons in boron or lithium.

(6). "Gamma Rays Excited by Capture of Neutrons" p. 323, 139. 1937.---jointly with Griffiths. Nature.
This paper reports on the observation of gamma rays emitted by a number of odd elements which are strong neutron absorbers. The counts observed per absorbed neutron were found to be 15 per cent identical for all these elements.

(7). "Radioactivity Induced by Nuclear Excitation" ---jointly with Goldhaber and Hill. p. 47, 55. 1939. Phys. Rev.
In this paper the previously reported period in indium is investigated and the conclusion is reached that it is due to nuclear excitation of the stable indium isotope 115.

(8). "Instantaneous Emission of Fast Neutrons in the Interaction of Slow Neutrons with Uranium"---jointly with Zinn. p. 799, 55, 1939. Phys. Rev.
In this paper the discovery of the neutron emission of uranium is reported. It is estimated that two neutrons are emitted per fission. The neutrons from uranium are made visible on an oscillograph screen. As primary neutrons, radium-beryllium photo neutrons were used which, because they are slow, can be easily distinguished from the fast neutrons emitted by uranium.

(9). "Emission of Neutrons by Uranium"---jointly with Zinn. p. 619, 56. 1939. Phys. Rev.
Detailed report of above mentioned experiments, number of neutrons per fission measured as 2.3.

(10). "Neutron Production and Absorption in Uranium"---jointly with Anderson and Fermi. p. 284, 56, 1939. Phys. Rev.
This paper reports an investigation on the chain reacting qualities of a uranium-water system. It is estimated that 1.5 neutrons are emitted for every thermal neutron which is absorbed by uranium.

The following of my papers were published between 1934 and 1940:

Chemical Separation of the Radioactive Element from its Bombarded Isotope in the Fermi Effect. Szilard and Chalmers. Nature Vol.134, 462. 1934.

Disintegration of Beryllium by Gamma-Rays of Radium. Szilard and Chalmers. Nature. 1934.

Anomalous Radioactivity induced in Indium by Neutrons. Szilard and Chalmers. Nature. 1935.

Residual Neutrons from Cadmium. Szilard. Nature. 1935.

Radioactivity induced by Nuclear Excitation. Szilard, Goldhaber and Hill. Physical Review,Vol.55. 1939.

Instantaneous Emission of Fast Neutrons in the Interaction of Slow Neutrons with Uranium. Szilard and Zinn. Physical Review,Vol.55. 1939.

Emission of Neutrons by Uranium. Zinn and Szilard. Physical Review. Vol.56. 1939.

Neutron Production and Absorption in Uranium. Anderson, Fermi and Szilard. Physical Review. Vol.56. 1939.

Leo Szilard
420 West 116th Street
New York City

The following papers of L.Szilard were published between 1934 and 1940 :

Szilard and Chalmers " Chemical Separation of the Radioactive Element from its Bombarded Isotope in the Fermi Effect." Nature 462. 134. 1934

Szilard and Chalmers " Detecting Neutrons liberated from Beryllium by Gamma Rays." Nature 494.134.1934

Szilard and Chalmers " Radioactivity induced by Neutrons (in Indium)" Nature 98.135.1935

Szilard " Absorption of Residual Neutrons "(from Cadmium) . Nature 950.136. 1935

Griffiths and Szilard "Gamma Rays excited by Capture of Neutrons" Nature 323.139.1937

Szilard, Goldhaber and Hill " Radioactivity induced by Nuclear Excitation" Physical Review, Vol 55.1939

Szilard and Zinn "Instantaneous Emission of Fast Neutrons in the Interaction of Slow Neutrons with Uranium " Physical Review, Vol 55. 1939

Zinn and Szilard " Emission of Neutrons by Uranium " Physical Review Vol. 56. 1939

Anderson, Fermi and Szilard " Neutron Production and Absorption in Uranium" Physical Review, Vol. 56. 1939.

List of Publications of Leo Szilard from 1948 to 1951

A. Novick and Leo Szilard. "Experiments on Light-Reactivation of Ultra-Violet Inactivated Bacteria." Proceedings of the National Academy of Sciences, Vol. 35, No. 10, pp. 591-600 (October, 1949).

In this paper an investigation is reported on the light reactivation of ultra-violet inactivated bacteria, a phenomenon described in 1948 by A. Kelner. The results obtained can be interpreted by assuming that the untra-violet light producing a sudden quantity of "poison" in an amount proportionate to the dose, that this "poison" is produced in two forms--a form which is not sensitive to light and a form which can be destroyed by light, the ratio in which two forms are produced being independent of the ultra-violet dose, and further that the number of bacteria surviving after exposure to ultra-violet with or without subsequent light-reactivation is determined by the amount of "poison" present in the bacteria at the time they are incubated with nutrient medium and permitted to multiply.

The results obtained on the effects of light reactivation on the number of mutants produced has been studied and the results are consistent with the view that the effect of light reactivation on the appearance of mutants among the progeny of the ultra-violet reactivated bacteria is the same as its effect on the number of survivors and consists in the reduction of the effectiveness of the ultra-violet does by the same dose independent factor. The question is raised whether the killing of the bacteria and the production of the mutants might thus be due to the same chemical effect produced by the ultra-violet irradiation.

A. Novick and Leo Szilard. "Description of the Chemostat." Science 112, 715 (1951).

In this paper a method is described for maintaining a bacterial population in the growth phase at a growth rate up to ten times lower than normal under the control of a specially selected growth factor, for instance tryptophane in the case of a tryptophane requiring strain of coli. Under the conditions prevailing in the Chemostat, a concentration of this growth factor in the growth tube is

independent of the concentration of the growth factor in the incoming nutrient and the bacterial density in the growth tube is independent of the flow rate of the incoming nutrient and is determined by the concentration of the growth factor in the incoming nutrient.

A. Novick and Leo Szilard. "Experiments with the Chemostat on Spontaneous Mutations of Bacteria." Proceedings of the National Academy of Sciences, 36, 708 (1950).

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In this paper it is shown that when bacteria are grown in the Chemostat with tryptophane as a controlling growth factor there is no selection against mutants to resistance to the bacterial viruses T5 and that the rate of mutation is not consistent per cell division but rather it is consistent per unit time. It is further described how evolution takes place in the growth tube of the Chemostat and how each step in the Evolution which consists in a strain which is more fit than the previous one

A. Novick and Leo Szilard. "Virus Strains of Identical Phenotype but Different Genotype." Science 113, 34 (1951)

In this paper it is shown that if two bacterial viruses T2 and T4 simultaneously multiply in a bacterium, there is present in the progeny a virus strain which is phenotypically like T4 but genotypically like T2; i.e., ~~xxxx~~ its host train is initially like that of T4, but after one passage as a susceptible host, the host strain is changed and becomes identical to that of the host strain of T2.

Description of the Chemostat.

Science 112, 715 (1951).

Virus Strains of Identical Phenotype but Different Genotype.

Science 113, 34 (1951)

Experiments with the Chemostat on Spontaneous Mutations of Bacteria.

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1955 ~~1954~~

C O P Y

LIST OF SCIENTIFIC PAPERS BY DR. LEO SZILARD
BETWEEN 1947 and 1954

1) A. Novick and Leo Szilard - EXPERIMENTS ON LIGHT-REACTIVATION OF ULTRA-VIOLET INACTIVATED BACTERIA. Proceedings of the NATIONAL ACADEMY OF SCIENCES. Vol. 35, No. 10, pp. 591-600.

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8) Maurice S. Fox and Leo Szilard: a device for growing bacterial populations under steady state conditions. Journal of Gen. Physiology, 39 p. 261 1955-6

The first of these papers (#1) investigates a phenomenon discovered by A. Kelner after the war, who showed that bacteria "killed" by ultra-violet light can be revived by shining visible light on them. Experiments designed to analyse the phenomenon are described in this paper; they lead to the conclusion that the

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compounds, all purine derivatives, of which caffein is one, which greatly increases the mutation rate without having an appreciable killing effect on the bacteria.

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In paper #7, the Chemostat is used to study the bio-synthesis of amino acids in bacteria and the regulatory mechanisms which are involved in it. The bio-synthetic apparatus of the bacteria respond to amino acid concentrations in the medium, which are exceedingly low. For instance, a bacterium which can make arginine and will do so if there is no arginine in the medium, will stop making arginine if an arginine concentration of 10^{-9} gm/cc is maintained in the medium in the Chemostat. (Novick and Szilard - unpublished.)

One way of studying such regulatory mechanisms is based on the use of a mutant which is blocked in the synthesis of an amino acid -- in our case Tryptophane -- and which pours out into the medium a "precursor" of that amino acid. Paper #7 utilizes such a mutant. In the absence of Tryptophane in the medium, a pre-cursor of Tryptophane is poured out by the mutant into the medium at a rate which is independent of the growth rate of the bacteria. In the presence of Tryptophane this "precursor" is <u>not</u> poured out by the bacteria. It is conceivable that this indicates a gen-eral phenomenon of regulation through a negative feed-back of the final product at one of the <u>early</u> steps of the metabolic pathway

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Curriculum D_2 — Descr. of Biol. papers to 1955 — 4 pages M

COPY

1955

LIST OF SCIENTIFIC PAPERS BY DR. LEO SZILARD
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Curriculum D, — Description of Biology papers to 1955 M

PUBLICATIONS OF LEO SZILARD FROM 1948 - 1955 3 pages

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CURRICULUM-D3 — 3 pages Description of Biology papers to 1955 M1

Beginning of Biology 1)

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18-2) Aaron Novick and Leo Szilard - VIRUS STRAINS OF IDENTICAL PHENOTYPE BUT DIFFERENT GENOTYPE. Science, January 12, 1951, Vol. 113, No. 2924, pp. 34-55.

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C O P Y

Compiled by the University of Colorado - 1949

I

PARTIAL BIBLIOGRAPHY OF DR. LEO SZILARD*

(1) Zeitschrift fur Physik, 1925, p. 753,32. This paper extends the application of thermodynamics to the derivation of the laws of thermodynamical fluctuations. It was accepted as dissertation by the University of Berlin.

(2) Zeitschrift fur Physik, 1925, p. 688, 33. — jointly with H. Mark. This paper reports experiments which revealed anomalous scattering of X-rays.

(3) Zeitschrift fur Physik, 1926, p. 743,35. — jointly with H. Mark. This paper reports experiments on polarizing X-rays by reflection on crystals.

(4) Zeitschrift fur Physik, 1929, p. 840,35. This paper evaluates the increase of entropy which is connected with operations of an intelligent being on a thermodynamical system if these operations are controlled by measurements of variables which are subject to thermodynamical fluctuations. This paper was accepted as Habilitationschrift by the University of Berlin.

(5) "Chemical Separation of the Radioactive Element from its Bombarded Isotope in the Fermi Effect" - - - jointly with Chalmers. Nature, p. 462, 134, 1934. This paper demonstrates a generally applicable process (Szilard-Chalmers reaction) for the concentration of a radioactive element produced by neutrons if the element has to be separated from a mass of a stable element with which it is chemically isotopic.

(6) "Detecting Neutrons Liberated from Beryllium by Gamma Rays," p. 494, 134, 1934. Nature.
This paper describes the discovery of radium-beryllium photo neutrons which, being of low energy, represent a useful tool in nuclear research. They were universally used later in the discovery and investigation of neutron emission of uranium on which a chain reaction is based.

(7) "Liberation of Neutrons from Beryllium by X-Rays" - - - jointly with a group of six others, p. 880, 134, 1934. Nature. Using X-rays in place of gamma rays the threshold for the emission of photo neutrons from beryllium is determined by varying the voltage of an X-ray tube and is found to be somewhat above 1.5, and well below 2 m.e.v.

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* Some of Dr. Szilard's most important works still remain unpublishable, for reasons of national security.

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This paper reports the discovery of neutron resonances at low energies, gives an estimate of their energies, and states that the energies can be measured by observing the absorption of the residual neutrons in boron or lithium.

(10) "Gamma Rays Excited by Capture of Neutrons," p. 323, 139. 1937 - - - jointly with Griffiths. Nature.
This paper reports on the observation of gamma rays emitted by a number of odd elements which are strong neutron absorbers. The counts observed per absorbed neutron were found to be 15 per cent identical for all these elements.

(11) "Radioactivity Induced by Nuclear Excitation" - - - jointly with Goldhaber and Hill, p. 47, 55. 1939. Phys. Rev.
In this paper the previously reported period in indium is investigated and the conclusion is reached that it is due to nuclear excitation of the stable indium isotope 115.

(12) "Instantaneous Emission of Fast Neutrons in the Interaction of Slow Nuetrons with Uranium" - - - jointly with Zinn, p. 799, 55, 1939. Phys. Rev.
In this paper the discovery of the neutron emission of uranium is reported. It is estimated that two neutrons are emitted per fission. The neutrons from uranium are made visible on an oscillograph screen. As primary neutrons, radium-beryllium photo neutrons were used which, because they are slow, can be easily distinguished from the fast neutrons emitted by uranium. This discovery which was made independently by Fermi in the same year indicated the feasibility of a sustaining nuclear chain reaction.

(13) "Emission of Neutrons by Uranium" - - - jointly with Zinn. P. 619, 56. 1939. Phys. Rev.
Detailed report of above mentioned experiments, number of neutrons per fission measured as 2.3.

(14) "Neutron Production and Absorption in Uranium" - - - jointly with Anderson and Fermi. p. 284, 56, 1939. Phys. Rev.
This paper reports an investigation on the chain reacting qualities of a uranium-water system. It is estimated that 1.5 neutrons are emitted for every thermal neutron which is absorbed by uranium.

See second list attached

(15) "Genetics-Experiments on Light-reactivation of Ultra-Violet Inactivated Bacteria" - - - jointly with A. Novick. P. 35, 591-599. 1949. Proceedings of National Academy of Sciences.

(16) The Chemostat - An Apparatus for Quantitative Measurement of Spontaneous Mutations of Bacteria." Science (In Press.)

(17) "Studies with the Chemostat on Spontaneous Mutations of Bacteria." Proceedings of National Academy of Sciences. (In Press.)

Dr. Szilard's part in ~~the~~ bringing about of the first nuclear chain reaction; in the design of the first nuclear reactor (atomic pile) are described, insofar as these matters can be made public, in the Official Report: Atomic Energy for Military Purposes, Henry D. ~~Smith~~ Smythe, 1945, Princeton University Press, pages 34, 47, etc.

List of Publications of Leo Szilard from 1948 to 1951

A. Novick and Leo Szilard. "Experiments on Light-Reactivation of Ultra-Violet Inactivated Bacteria." Proceedings of the National Academy of Sciences, Vol. 35, No. 10, pp. 591-600 (October, 1949).

In this paper an investigation is reported on the light reactivation of ultra-violet inactivated bacteria, a phenomenon described in 1948 by A. Kelner. The results obtained can be interpreted by assuming that the untra-violet light producing a sudden quantity of "poison" in an amount proportionate to the dose, that this "poison" is produced in two forms--a form which is not sensitive to light and a form which can be destroyed by light, the ratio in which two forms are produced being independent of the ultra-violet dose, and further that the number of bacteria surviving after exposure to ultra-violet with or without subsequent light-reactivation is determined by the amount of "poison" present in the bacteria at the time they are incubated with nutrient medium and permitted to multiply.

The results obtained on the effects of light reactivation on the number of mutants produced has been studied and the results are consistent with the view that the effect of light reactivation on the appearance of mutants among the progeny of the ultra-violet reactivated bacteria is the same as its effect on the number of survivors and consists in the reduction of the effectiveness of the ultra-violet does by the same dose independent factor. The question is raised whether the killing of the bacteria and the production of the mutants might thus be due to the same chemical effect produced by the ultra-violet irradiation.

A. Novick and Leo Szilard. "Description of the Chemostat." Science 112, 715 (1951).

In this paper a method is described for maintaining a bacterial population in the growth phase at a growth rate up to ten times lower than normal under the control of a specially selected growth factor, for instance tryptophane in the case of a tryptophane requiring strain of coli. Under the conditions prevailing in the Chemostat, a concentration of this growth factor in the growth tube is

independent of the concentration of the growth factor in the incoming nutrient and the bacterial density in the growth tube is independent of the flow rate of the incoming nutrient and is determined by the concentration of the growth factor in the incoming nutrient.

A. Novick and Leo Szilard. "Experiments with the Chemostat on Spontaneous Mutations of Bacteria." Proceedings of the National Academy of Sciences, 36, 708 (1950).

~~In this paper a method is described for maintaining a bacterial population in the growth phase at a growth rate up to ten times lower than normal under the control of a specially selected grwoth factor, for instance~~

In this paper it is shown that when bacteria are grown in the Chemostat with tryptophane as a controlling growth factor there is no selection against mutants to resistance to the bacterial viruses T5 and that the rate of mutation is not consistent per cell division but rather it is consistent per unit time. It is further described how evolution takes place in the growth tube of the Chemostat and how each step in the evolution which consists in a strain which is more fit than the previous one

A. Novick and Leo Szilard. "Virus Strains of Identical Phenotype but Different Genotype." Science 113, 34 (1951)

In this paper it is shown that if two bacterial viruses T2 and T4 simultaneously multiply in a bacterium, there is present in the progeny a virus strain which is phenotypically like T4 but genotypically like T2; i.e., ~~xxxx~~ its host train is initially like that of T4, but after one passage as a susceptible host, the host strain is changed and becomes identical to that of the host strain of T2.

PUBLICATIONS OF LEO SZILARD FROM 1948 - 1955

1)	A. Novick and Leo Szilard -	EXPERIMENTS ON LIGHT-REACTIVATION OF ULTRA-VIOLET INACTIVATED BACTERIA. Proceedings of the NATIONAL ACADEMY OF SCIENCES. Vol. 35, No. 10, pp. 591-600.
2)	Aaron Novick and Leo Szilard -	VIRUS STRAINS OF IDENTICAL PHENOTYPE BUT DIFFERENT GENOTYPE. Science, January 12, 1951, Vol. 113, No. 2924, pp. 34-55.
3)	Aaron Novick and Leo Szilard -	EXPERIMENTS WITH THE CHEMOSTAT ON SPONTANEOUS MUTATIONS OF BACTERIA. Proceedings of the NATIONAL ACADEMY OF SCIENCES. Vol. 36, No. 12, pp. 706-719, December, 1950.
4)	Aaron Novick and Leo Szilard -	DESCRIPTION OF THE CHEMOSTAT. Science, December 15, 1950. Vol. 112, No. 2920, pp. 715-716.
5)	Aaron Novick and Leo Szilard -	EXPERIMENTS ON SPONTANEOUS AND CHEMICALLY INDUCED MUTATIONS OF BACTERIA GROWING IN THE CHEMOSTAT. Cold Spring Harbor Symposia on Quantitative Biology. Vol. XVI, 1951.
6)	Aaron Novick and Leo Szilard -	ANTI-MUTAGES. Nature, Vol. 170, p. 926, November 29, 1952.
7)	A. Novick and Leo Szilard -	EXPERIMENTS WITH THE CHEMOSTAT ON THE RATES OF AMINO ACID SYNTHESIS IN BACTERIA. Dynamics of Growth Processes. Princeton University Press, pp. 21-32, 1954.
8)	Maurice S. Fox and Leo Szilard -	A DEVICE FOR GROWING BACTERIAL POPULATIONS UNDER STEADY STATE CONDITIONS. Journal of General Physiology 39, p. 261-6, 1955.

The first of these papers (1) investigates a phenomenon discovered by A. Kelner after the war, who showed that bacteria "killed" by ultra-violet light can be revived by shining visible light on them. Experiments designed to analyze the phenomenon are described in this paper; they lead to the conclusion that the ultra-violet light produces a "poison" which can be inactivated by light and that this "poison",

if present when, subsequent to irradiation, the bacteria divide, will cause both death and mutations.

The second paper (2) describes the discovery that, when a bacterium is infected simultaneously with two related viruses which differ from each other both in genotype and phenotype, the virus population emerging from the bacterium contains a class of viruses which have the genotype of one and the phenotype of the other.

The papers Nos. 3 to 7 describe a new way of studying bacteria by maintaining a bacterial population in a stationary (exponentially growing) state indefinitely and controlling the growth rate by controlling the rate of supply of an essential growth factor. An apparatus is described in these papers which will conveniently accomplish this and which is designated as the Chemostat.

In studying mutations in bacteria or the formation of adaptive enzymes in bacteria inaccurate, and therefore misleading, results are frequently obtained by studying bacterial cultures in flasks in which the number of bacteria increases exponentially and today the use of the Chemostat appears to be indispensable.

In the papers Nos. 3 to 6, the Chemostat is used in the study of mutations. It turns out that the rate at which mutations occur in a growing bacterial population under the conditions studied is not proportional to the rate at which cell division occurs, rather the mutation rate is constant per unit time independent of the rate at which the culture is growing. There is found one group of compounds, all purine derivatives, of which caffein is one, which greatly increases the mutation rate without having an appreciable killing effect on the bacteria.

There is another group of compounds described in these papers, all of them ribosides of purines which in small quantities will completely counteract the action of the above mentioned purine type mutagens and also reduce the rate of spontaneous mutations.

In paper No. 7, the Chemostat is used to study the biosynthesis of amino acids in bacteria and the regulatory mechanisms which are involved in it. The biosynthetic apparatus of the bacteria respond to amino acid concentrations in the medium, which are exceedingly low. For instance, a bacterium which can make arginine and will do so if

there is no arginine in the medium, will stop making arginine if an arginine concentration of 10^{-9} ga/ce is maintained in the medium in the Chemostat. (Novick and Szilard - unpublished.)

One way of studying such regulatory mechanisms is based on the use of a mutant which is blocked in the synthesis of an amino acid -- in our case Tryptophane -- and which pours out into the medium a "precursor" of that amino acid. Paper No. 7 utilizes such a mutant. In the absence of Tryptophane in the medium, a precursor of Tryptophane is poured out by the mutant into the medium at a rate which is independent of the growth rate of the bacteria. In the presence of Tryptophane this "precursor" is <u>not</u> poured out by the bacteria. It is conceivable that this indicates a general phenomenon of regulation through a negative feed-back of the final product at one of the <u>early</u> steps of the metabolic pathway leading to Tryptophane.

In paper No. 8, there is described a device called a breeder. In this device bacteria may be grown in a continuous flow of nutrient. The flow of the nutrient is controlled by the turbidity of the bacterial culture and the growth is not limited by a growth factor, as is the case in the "Chemostat."

This device was developed in order to study mutations in bacteria under conditions of growth at the maximal rate, and such study was carried out by Maurice S. Fox.

PUBLICATIONS OF LEO SZILARD FROM 1948 - 1955

17 1) A. Novick and Leo Szilard - EXPERIMENTS ON LIGHT-REACTIVATION OF ULTRA-VIOLET INACTIVATED BACTERIA. Proceedings of the NATIONAL ACADEMY OF SCIENCES. Vol. 35, No. 10, pp 591-600.

18 2) Aaron Novick and Leo Szilard - VIRUS STRAINS OF IDENTICAL PHENOTYPE BUT DIFFERENT GENOTYPE. Science, January 12, 1951, Vol. 113, No. 2924, pp. 34-35.

19 3) Aaron Novick and Leo Szilard - EXPERIMENTS WITH THE CHEMOSTAT ON SPONTANEOUS MUTATIONS OF BACTERIA. Proceedings of the NATIONAL ACADEMY OF SCIENCES. Vol. 36, No. 12, pp. 706-719, December, 1950.

20 4) Aaron Novick and Leo Szilard - DESCRIPTION OF THE CHEMOSTAT. Science, December 15, 1950. Vol. 112, No. 2920, pp. 715-716.

21 5) Aaron Novick and Leo Szilard - EXPERIMENTS ON SPONTANEOUS AND CHEMICALLY INDUCED MUTATIONS OF BACTERIA GROWING IN THE CHEMOSTAT. Cold Spring Harbor Symposia on Quantitative Biology. Vol. XVI, 1951.

22 6) Aaron Novick and Leo Szilard - ANTI-MUTAGES. Nature, Vol. 170, p. 926, November 29, 1952.

23 7) A. Novick and Leo Szilard - EXPERIMENTS WITH THE CHEMOSTAT ON THE RATES OF AMINO ACID SYNTHESIS IN BACTERIA. Dynamics of Growth Processes. Princeton University Press, pp. 21-32, 1954.

24 8) Maurice S. Fox and Leo Szilard - A DEVICE FOR GROWING BACTERIAL POPULATIONS UNDER STEADY STATE CONDITIONS. Journal of General Physiology 39, p. 261-6, 1955.

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The first of these papers (#1) investigates a phenomenon discovered by A. Kelner after the war, who showed that bacteria "killed" by ultra-violet light can be revived by shining visible light on them. Experiments designed to analyze the phenomenon are described in this paper; they lead to the conclusion that the ultra-violet light produces a "poison" which can be

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In paper 23 #7, the Chemostat is used to study the biosynthesis of amino acids in bacteria and the regulatory mechanisms which are involved in it. The bio-synthetic apparatus of the bacteria respond to amino acid concentrations in the medium, which are exceedingly low. For instance, a bacterium which can make arginine and will do so if P.3 there is no arginine in the medium, will stop making arginine if an arginine concentration of 10^{-9} ga/ce is maintained in the medium in the Chemostat. (Novick and Szilard - unpublished.)

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KEY TO ABBREVIATIONS

~~Bull. Atomic Scientists = Bulletin of Atomic Scientists~~
Cold Spring Harbor Symp. Quant. Biol. = Cold Spring Harbor Symposia on Quantitative Biology
Phys. Rev. = Physical Review
Proc. Nat. Acad. Sci. = Proceedings of the National Academy of Sciences
Zeits. Physik = Zeitschrift für Physik

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II. EXPERIMENTS WITH THE CHEMOSTAT ON THE RATES OF AMINO ACID SYNTHESIS IN BACTERIA

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b) CHEMICAL SEPARATION OF RADIOACTIVE ELEMENTS FROM NON-RADIOACTIVE ISOTOPES

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Leo Szilard

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1) CP-285 (12/12/41): Preliminary Report on Inelastic Collision of Neutrons in Uranium and other Heavy Elements, with W. H. Zinn.

2) CP-316 (11/14/41): Preliminary Report on Fission Caused by Fission Neutrons, with J. Marshall, Jr.

3) CP-317 (12/5/41): Preliminary Report on the Capture of Neutrons by Uranium in the Energy Region of Photo Neutrons from Radium Beryllium Sources, with J. Marshall.

4) CF-338 (12/16/41) Memorandum on the Critical Condition for a Fast Neutron Chain Reaction inside a Spherical Shell of Uranium Metal, with B. T. Feld

5) C-189 (7/10/42): Approximate Boundary Condtions for Diffusion Equation at Interface between two Media. with A. M. Weinberg, E. P. Wigner, and R. F. Christy

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~~IV.~~ a. Physics:

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2. CF-1117 (12/29/43). Neutron Emission in Fission of U^{238}, with B. Feld, J. Ashkin, S. Bernstein, L. Crentz, J. Kelsner and R. Scalettar.

3. MDDC-1292 (date unknown) Inelastic Scattering of Fast neutrons, with S. Bernstein and B. T. Feld

4. MDDC-1536 (8/27/47) Inelastic Scattering of Fe, Pb, and Bi, with S. Bernstein, B. Feld, and J. Ashkin (Phys. Rev. 73, 1307 (1948))

5. Use of Threshold Detectors for Fast Neutron Studies, with B. Feld and R. Scalettar (Phys. Rev. 71, 464 (1947)). Abstract.

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III. b. Metallurgy and Engineering: *

1) A-24 (8/16/41): Preliminary Report on the Melting of Uranium Powder.

2) C-130 (6/15/42): On the Cooling of the Power Plant (with addenda C-146 and C-150).

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1. CP-308 (6/18/42). Examples of Pressure Drop Calculations in Parallel Flow Helium Cooling, with B. T. Feld.
2. CF-279 (7/14/42). A Magnetic Pump for Liquid Bismuth, with B. Feld.
3. CP-360 (11/23/42). Short Memorandum on Bismuth Cooled Power Unit
4. MUC-LS-60 (3/16/45). Liquid Metal Cooled Fast Neutron Breeder.

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CHEMICAL SEPARATION OF THE RADIOACTIVE ELEMENT FROM ITS BOMBARDED ISOTOPE IN THE FERMI EFFECT

by Dr. Leo Szilard and T. A. Chalmers

Letter to the Editor, dated Sept 10, 1934

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DETECTION OF NEUTRONS LIBERATED FROM BERYLLIUM BY GAMMA RAYS: A NEW TECHNIQUE FOR INDUCING RADIOACTIVITY

by Dr. Leo Szilard and T. A. Chalmers

Letter to the Editor, dated Sept 17, 1934

O.K. to reprint

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LIBERATION OF NEUTRONS FROM BERYLLIUM BY X-RAYS: RADIOACTIVITY INDUCED BY MEANS OF ELECTRON TUBES

A. Brasch
F. Lange
A. Waly
T. E. Banks
T. A. Chalmers
Leo Szilard
F. L. Hopwood

Letter to the Editor

O.K. to reprint

dated Nov 26, 1934

Nature, 135:98 (Jan. 19) 1935 PHY 8

RADIOACTIVITY INDUCED BY NEUTRONS

Leo Szilard
T. A. Chalmers

Letter to the Editor, dated Dec 18, 1934

O.K. to reprint

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ABSORPTION OF RESIDUAL NEUTRONS

Leo Szilard

Letter to the Editor, dated Nov 19, 1935

O.K. to reprint

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Leo Szilard

Letter to the Editor, dated Jan 20, 1937

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Leo Szilard
Walter H. Zinn

Letter to the Editor, dated March 16, 1939

O.K. to reprint

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W. H. Zinn
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O.K. to reprint

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H. L. Anderson, E. Fermi and Leo Szilard

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By A. Novick and Leo Szilard

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Science, 112:715-716 (Dec. 15) 1950 Bio 4

DESCRIPTION OF THE CHEMOSTAT

Aaron Novick and Leo Szilard

Technical Paper
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By Aaron Novick and Leo Szilard

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VIRUS STRAINS OF IDENTICAL PHENOTYPE BUT DIFFERENT GENOTYPE

Aaron Novick and Leo Szilard

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Aaron Novick
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Leo Szilard

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