NATIONAL ACADEMY OF SCIENCES

DWIGHT JOYCE INGLE

1907—1978

A Biographical Memoir by

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Biographical Memoir

Courtesy, Department of Public Relations, University of Chicago

DWIGHT JOYCE INGLE

September 4, 1907–July 28, 1978

BY MAURICE B. VISSCHER

IT IS DIFFICULT to compress into a memoir of reasonable length the story of a scientist who was born on an Idaho ranch, educated in an ungraded elementary school and small town high school, attended a newly established state university, and yet went on to become a first-rank, pioneering scientist in a new and uncharted field. Yet even from this short account it will be apparent that his life was of importance to the advancement, philosophy, and ethics of science.

The period of Dwight Ingle's active life was the time of rapid development in endocrine science, to which Ingle himself contributed greatly. His career included a series of statistically improbable successful ventures, chronicled in his autobiography, *I Went to See the Elephant.*[1] The title comes from John Godfrey Saxe's story of "the six blind men of Indostan," who describe an elephant according to the part of the animal they can touch with their hands, and Ingle displayed genuine modesty in choosing it, for, as he explains in the book's preface, "Science does involve looking at some specific properties of systems that are too big to get into perspective." With a simple and genuine modesty, he continues:

This may be the first time that a non-famous scientist has written an autobiography. I hope it will show that an ordinary fellow can have fun being a scientist. There has been some self-direction in my life, but it may well be that the origin of some of my drives and faiths are hidden. Fortuity has played an important role in determining my interest, opportunities, and what has become of me.[1]

EDUCATION AND EARLY LIFE

Dwight Joyce Ingle was born September 4, 1907, on a ranch near Kendrick, Idaho. He attended a small country elementary school and graduated from high school in Kendrick. At eighteen he entered the University of Idaho with a career as a physical education director in mind. Interested in weightlifting and wrestling since he was a boy, he had not yet acquired any real interest in science though he was a voracious reader. This situation changed very soon under the influence of the faculty.

Ingle's first serious scientific interest was in the field of psychology, which perhaps intrigued him because he engaged in summer work in state mental hospitals in Idaho. As he tells the story in his autobiography, he soon became disillusioned with the treatment and methods of care then available for the mentally ill, coming early to the conclusion that psychoses are organic illnesses. His interests, therefore, shifted to physiological psychology. Earning the Bachelor of Science degree at the University of Idaho in 1929, he enrolled there as a graduate student and earned a Master's degree in psychology in 1931. During his years at the University of Idaho, Ingle began reading the literature of endocrinology and studying adrenalectomized animals. He supported himself as a graduate student by working part time as a laboratory animal caretaker and by grading examination papers.

The Great Depression was then under way in the United States, and life was hard for most graduate students. Ingle was offered a small stipend as a teaching assistant at the Uni-

versity of Minnesota that allowed him to continue his graduate studies. He knew of Karl Lashley and others' basic work in physiological psychology at Minnesota and planned to emulate them. As it happened, however, his interests and his work shifted from psychology to fundamental endocrinology.

The author of this memoir was a member of the University of Minnesota Graduate School Committee that conducted Dwight Ingle's final examinations for the Ph.D. degree. He had majored in psychology and minored in physiology, of which I was the representative. My first experience with the candidate was in connection with his petition to the Graduate School to be exempted from the foreign language requirements for the Ph.D., which had never been waived before that time, and I remember vividly the consternation this request raised in the Graduate School community. Ingle's examining committee took account of the sixty high-quality scientific papers that he had already published and concluded that Ingle had demonstrated his fitness for a doctorate. There was no dissent among the committee members.

The Ingle case was a landmark decision for the Graduate School at Minnesota and was followed by many more examples of breaking traditional rules and regulations at that institution. I was somewhat surprised, therefore, that Ingle himself made no mention in his autobiography of his stubborn refusal to bother with things like foreign language requirements, which he undoubtedly considered much less important than learning how to remove part or all of a rat's pituitary gland at the age of weaning. He was, of course, right, but in his mention of his Ph.D. examination he refers only to the fact that he was asked only one question relating to psychology, his major field, the examination being dominated by questions on biology and physiology.

After completing his graduate studies at the University of Minnesota Ingle moved to the Mayo Clinic, where he

was a Mayo Fellow for four years and collaborated with E. C. Kendall's group in studies of the hormones of the adrenal cortex. He then became a Cox Medical Research Fellow at the University of Pennsylvania, where he worked for three years under the sponsorship of Dr. F. D. W. Lukens.

After the termination of the Cox Fellowship, Ingle worked for the Upjohn Company in Kalamazoo, Michigan. In his twelve years there he became a senior research scientist and conducted a basic research program in endocrinology without pressure to work on problems of specific importance to the company. Yet he became restive, and when he was offered a professorship of physiology in The University of Chicago's Ben May Institute, he left Michigan for Chicago, remaining there from 1953 until his retirement twenty years later. Chairman of the Department of Physiology for nine years, he was not happy as an academic administrator and relinquished the post before he retired.

INGLE AND THE NEW FIELD OF ENDOCRINOLOGY

As noted above, Ingle came onto the scientific scene when endocrinology was emerging as a major field of science. He offered the new field freshness of approach and imagination, strict critical thinking, and boundless energy for painstaking work. Perhaps his greatest asset was his ability to define problems in a way that could be answered by direct observation in experimental situations. In reviewing his very large scientific output, it is obvious that he excelled at asking specific questions and spared no pains in devising methods to answer them.

Ingle is responsible for at least three signal advances in endocrine science—development of a bioassay for adrenal cortical hormones that facilitated the purification of cortisone, documentation that the adrenal cortex and the pituitary gland interact by a negative feedback mechanism, and

characterization of the permissive role of adrenal hormones in homeostatic control mechanisms. His contributions are described in detail in his own autobiography[1] and in E. C. Kendall's autobiography.[2]

The first of these advances stemmed from a 1934 paper in which Ingle (together with W. T. Heron and W. M. Hales) reported that repetitive contraction of skeletal muscle requires an intact adrenal cortex. Ingle suggested to E. C. Kendall that this phenomenon could be utilized as a bioassay for the activity of adrenal cortical extracts. Kendall immediately realized the potential of such a bioassay in the purification of adrenal hormones and invited Ingle to join his group at the Mayo Clinic, an appointment that Kendall described as a turning point in the purification of the glucocorticoid hormone cortisone.[2] The assay provided reliable data as to which purified fractions contained the active principle and gave the Mayo group an advantage over competing laboratories that lacked such an assay. During these early studies he characterized the relation between the adrenal gland and salt and water metabolism, a phenomenon that subsequently became the basis of another bioassay system that led to the recognition that the adrenal cortex also secretes a mineralocorticoid hormone, later characterized as aldosterone.

Another side observation of the studies at the Mayo Clinic led to his second major contribution, namely in 1937 Ingle observed that the administration of adrenal cortical extracts or purified glucocorticoids to intact rats causes atrophy of the adrenal glands. Adrenal atrophy could be prevented by the simultaneous administration of pituitary extracts, and he subsequently established in collaborative work with Herbert M. Evans and Choh H. Li that the changes in adrenal size and activity are mediated by the pituitary hormone adrenocorticotropin. The elucidation of the feedback relation between the adrenal cortex and the pituitary

gland served as a paradigm for similar control mechanisms in other endocrine systems.

His third major contribution evolved from his studies of the physiological actions of adrenal steroid hormones, a train of thought that led to excursion into diverse aspects of physiology, including studies of the effects of adrenal steroids on carbohydrate physiology, investigations on the pathogenesis of hypotension (shock) in animals with adrenal insufficiency, and the effects of severe stress on animals. The damaging effects of stress were widely believed to be due to hypersecretion of the adrenal cortex. However, Ingle showed that the characteristic damaging effects of stress are produced when adrenal steroids are supplied to adrenalectomized animals at a constant but not excessive rate of administration. He thus deduced that the role of the adrenal cortex in the stressed state appears to be due to a subtle "permissive" or supporting role rather than as the primary mediator of the stress reaction. This paradigm has had an enormous impact on the analysis of endocrine systems.

PERSPECTIVES IN BIOLOGY AND MEDICINE AND THE ETHICS OF RESEARCH

At Chicago Ingle founded a hybrid journal of a type that had never existed before. *Perspectives in Biology and Medicine* published papers from the interface between the biomedical sciences and the humanities. To Ingle *Perspectives* was the forum where the "ordinary fellow" could explore and integrate "two cultures"—a term he coined long before E. P. Snow applied it as a catch phrase for the gap between humanists and scientists. With the encouragement and help of The University of Chicago Press, Ingle provided a single publication medium to serve the two groups, demonstrating in a practical way that differing points of view could have a commonality of objectives.

Perspectives published various types of speculative essays on basic science and the ethics of biomedical research—particularly useful at a time when serious problems so often involve situations where biological science and ethics intersect. Having first provided a forum for the rational presentation of varying viewpoints, Ingle used the journal frequently to air his own analyses of such problems.

Ever careful to give credit to his own research staff, Ingle felt particularly strongly about the impropriety of senior research directors who report the results of students without acknowledging their ideas and implementation. At the Endocrine Society's annual banquet in 1959, his presidential address included an elaborate fable about a scientist born with "a mutation that enhanced the ability of the brain to function creatively." This mutation had come about when a clergyman grandfather was struck by a single neutron while "bent over an ice cream freezer at a church social." Skipping the son, who became a mail carrier, it manifested itself in the grandson.

Tongue in cheek, Ingle went on to describe how the grandson became a promising graduate student and made an entirely independent discovery that greatly pleased his advisor. The advisor asked the young man if he might disclose the finding publicly in an important address he was about to deliver. Receiving consent, he dutifully reported that his graduate student had made an exciting discovery. To no one's surprise but the student's, however, the next day's headlines read, "Professor X announces a major discovery." Professor X then became a noted participant in scientific seminars and a frequent guest lecturer on the subject of the student's discovery.

According to Ingle's fable, Professor X rode to fame and fortune while the young student, if not ignored, was recognized only by serious students of his field. Promoted rap-

idly in prestigious academic institutions, he soon became a full professor with productive graduate students of his own. One day, a student reported to him a highly significant result gained from entirely independent studies. As it happened, the young professor was just about to give a talk on the work going on in his department, and he asked the graduate student's permission to report his unpublished results. He felt a little qualm when he remembered his own dismay when credit for his work as a student went to his academic sponsor but reminded himself that he provided the intellectual climate in which his students worked and the stipends to live and develop into creative scientists. And so it was that the grandson announced his student's innovative study, and the next day the headlines read, "Professor Y announces spectacular new scientific results"—with predictably favorable consequences to his career.

This tale occupies eight pages of Ingle's autobiography, where he details several stages of the successful scientific career: appointments to journal editorships, membership on foundation and government grants committees, administrative posts. An inveterate storyteller but never abrasive, he used a gently satirical tone to criticize people of his own ilk. He poked fun at human frailties but was generous and forgiving.

AWARDS AND HONORS

Ingle received much honor and acclaim for his contributions to endocrinology. He was invited to lecture many times at home and abroad. He was awarded the Honorary Doctor of Science degree by the University of Idaho in 1962, received the Koch Award of the Endocrine Society, and was elected to the National Academy of Sciences in 1963. He was given the Outstanding Achievement Award of the University of Minnesota in 1964, the Roche-Organon

Laurentian Hormone Conference Award, and the Upjohn Prize. He was elected a fellow of the American Academy of Arts and Sciences and was given the Modern Medicine Achievement Award. He was a member of Phi Beta Kappa, Sigma Xi, Alpha Omega Alpha, the American Association for the Advancement of Science, the American Physiological Society, the Endocrine Society (president, 1959–60), and the Society for Experimental Biology and Medicine (president, 1965–67).

"My research efforts have been driven by curiosity," he once wrote, when asked what motivated him to do scientific research. "The joy of the daily search has been enhanced by occasional discovery."

He will long be remembered as a perceptive, careful, and creative scientist of broad intellectual interests—and as an unusually decent human being; definitely not, as he himself put it, "an ordinary fellow."

NOTES

1. D. J. Ingle, *I Went to See the Elephant* (New York: Vantage Press, 1963).

2. E. C. Kendall, *Cortisone. Memoirs of a Hormone Hunter* (New York: Charles C. Scribner's Sons, 1971).

SELECTED BIBLIOGRAPHY

The entire bibliography is deposited in the Dwight J. Ingle Collection, American Heritage Center Library, The University of Wyoming, Laramie, WY 82071.

1934

With W. T. Heron and W. M. Hales. Capacity of skeletal muscle in rats to maintain work output. *Am. J. Physiol.* 110:357–61.

1935

With W. M. Hales and G. M. Haslerud. Influence of partial adrenalectomy on the work capacity of rats. *Am. J. Physiol.* 113:200–204.

Endocrine function and personality. *Psychol. Rev.* 42:466–79.

1936

With E. C. Kendall. Survival of the adrenalectomized nephrectomized rat. *Am. J. Physiol.* 116:622–25.

With E. C. Kendall. Survival of the adrenalectomized nephrectomized rat. *Am. J. Physiol.* 117:200–202.

1937

With G. M. Higgins. Transplantation and regeneration of the adrenal gland in the rat. *Proc. Staff Meet. Mayo Clinic* 12:204–5.

With E. C. Kendall. The effect in the rat of cortin on the regeneration of the adrenal gland after enucleation. *Proc. Staff Meet. Mayo Clinic* 12:505.

With R. E. Harris. The influence of destruction of the adrenal medulla on emotional hyperglycemia in rats. *Am. J. Physiol.* 120:420–22.

With E. C. Kendall. The significance of the adrenals for adaptation to mineral metabolism. *Science* 86:18–19.

With E. C. Kendall. Atrophy of the adrenal cortex of the rat produced by the administration of large amounts of cortin. *Science* 86:245.

1938

With G. M. Higgins. Functional homeoplastic grafts of the adrenal gland of newborn rats. *Anat. Rec.* 70:145–54.

With G. M. Higgins. Influence of genetic relationship on the suc-

cess of homeoplastic transplants of adrenal glands in Albino rats. *Proc. Soc. Exp. Biol. Med.* 39:165–66.

With E. C. Kendall. Weights of adrenal glands in rats fed different amounts of sodium and potassium. *Am. J. Physiol.* 122:585–88.

With H. D. Moon and H. M. Evans. Work performance of hypophysectomized rats treated with anterior pituitary extracts. *Am. J. Physiol.* 123:620–24.

With G. M. Higgins. Autotransplantation and regeneration of the adrenal gland. *Endocrinology* 22:458–64.

The work performance of untreated hypophysectomized rats. *Endocrinology* 22:465–68.

With G. M. Higgins. The effect of the administration of carbon tetrachloride on the extent of regeneration in the enucleated adrenal gland of the rat. *Endocrinology* 23:424–28.

With G. M. Higgins and E. C. Kendall. Atrophy of the adrenal cortex in the rat produced by the administration of large amounts of cortin. *Anat. Rec.* 71:363–72.

With G. M. Higgins. Regeneration of the adrenal gland following enucleation. *Am. J. Med. Sci.* 196:232–39.

The effect of administration of large amounts of cortin on the adrenal cortical atrophy in male and female rats. *Proc. Staff Meet. Mayo Clinic* 13:733–34.

A comparison of the amounts of cortin required to produce adrenal cortical atrophy in male and female rats. *Proc. Staff Meet. Mayo Clinic* 13:733–34.

1939

With G. M. Higgins. Regeneration of the liver in hypophysectomized white rats. *Anat. Rec.* 73:95–104.

With E. V. Flock and J. L. Bollman. Formation of lactic acid, an initial process in working muscle. *J. Biol. Chem.* 129:99–110.

With W. C. Corwin. Coagulation time of blood in normal and adrenal-demedullated rats. *Proc. Soc. Exp. Biol. Med.* 42:82–84.

1940

With R. E. Harris. The capacity of vigorous muscular activity of normal rats and of rats after removal of the adrenal medulla. *Am. J. Physiol.* 130:151–54.

Effect of two steroid compounds on weight of thymus of adrenalectomized rats. *Proc. Soc. Exp. Biol. Med.* 44:174–75.

Diabetogenic effect of some cortin-like compounds. *Proc. Soc. Exp. Biol. Med.* 44:176–77.

Effect of three synthetic steroid compounds upon weight and work performance of adrenalectomized rats. *Proc. Soc. Exp. Biol. Med.* 44:450–52.

With J. Q. Griffith, Jr. Blood volume in experimental hypertension following subtotal nephrectomy. Effect of posterior pituitary lobectomy. *Proc. Soc. Exp. Biol. Med.* 44:538–40.

With E. C. Kendall. Influence of amorphous fraction from adrenal cortex on efficiency of muscle. *Proc. Soc. Exp. Biol. Med.* 45:602–6.

With A. T. Rasmussen, W. J. Gardner, and T. B. Rasmussen. Effects of hypophysectomy and hypophysial stalk resection on the hypothalamic nuclei of animals and man. *Assoc. Res. Nerv. Ment. Dis.* 20:245–69.

1941

With G. W. Thorn. A comparison of the effects of 11-desoxycorticosterone acetate and 17-hydroxy-11-dehydrocorticosterone in partially depancreatized rats. *Am. J. Physiol.* 132:670–78.

With J. F. Grattan and H. Jensen. The effect of the pituitary adrenocorticotrophic hormone and of corticosterone acetate on insulin hypoglycemia and liver glycogen in adrenalectomized mice. *Am. J. Physiol.* 134:8–11.

The production of glycosuria in the normal rat by means of 17-hydroxy-11-dehydrocorticosterone. *Endocrinology* 29:649–52.

Diabetogenic effect of stilbestrol in force-fed normal and partially depancreatized rats. *Endocrinology* 29:838–48.

1942

The use of the rat in the biologic assay of the hormone. In *The Rat in Laboratory Investigation,* pp. 295–300. Philadelphia: J. B. Lippincott Co.

With J. Q. Griffith. Surgery of the rat. In *The Rat in Laboratory Investigation,* pp. 434–52. Philadelphia: J. B. Lippincott Co.

1944

With C. H. Li and H. M. Evans. The effect of pure adrenocorticotrophic hormone on the work performance of hypophysectomized rats. *Endocrinology* 35:91–95.

The physiological action of the adrenal hormones. In *The Chemistry*

and Physiology of Hormones, pp. 83–103. Washington, D.C.: American Association for the Advancement of Science.

1945

Metabolic functions of the endocrine system. *Annu. Rev. Physiol.* 7:527–66.

With H. A. Winter, C. H. Li, and H. M. Evans. Production of glycosuria in normal rats by means of adrenocorticotrophic hormone. *Science* 101:671–72.

With M. L. Pabst, and M. H. Kuizenga. The effect of pretreatment on the relative potency of 11–desoxycorticosterone acetate and 17-hydroxy-11-dehydrocorticosterone in the muscle work test. *Endocrinology* 36:426–30.

A further study of the effect of diet on adrenal weights in rats. *Endocrinology* 37:7–14.

With R. Sheppard, J. S. Evans, and M. H. Kuizenga. A comparison of adrenal steroid diabetes and pancreatic diabetes in the rat. *Endocrinology* 37:341–56.

Alimentary glycosuria in the rat. *Endocrinology* 37:488–89.

1946

With G. M. Higgins. The relation of the hypophysis to certain changes induced in the rat by the goitrogen, promizole. *Endocrinology* 38:110–21.

With C. H. Li and H. M. Evans. The effect of adrenocorticotrophic hormone on the urinary excretion of sodium, chloride, potassium, nitrogen and glucose in normal rats. *Endocrinology* 39:32–42.

Experimental hyperadrenocorticism and its possible relationship to some of the metabolic changes caused by stress in the rat. In *Conference on Metabolic Aspects of Convalescence,* Transactions of the 13th Meeting of the Josiah Macy, Jr., Foundation, pp. 117–42. New York: Josiah Macy, Jr., Foundation.

1947

With J. E. Nezamis. Effect of adrenalectomy upon survival time of the eviscerated rat. *Proc. Soc. Exp. Biol. Med.* 64:424–25.

With G. M. Higgins and O. R. Joneson. The effect of synthetic lactobacillus casei factor on the blood changes induced by gastrectomy in the rat. *J. Lab. Clin. Med.* 32:635–43.

With J. A. Hogg. Diabetogenic effect of two synthetic estrogens in force-fed, alloxan-diabetic rats. *Proc. Soc. Exp. Biol. Med.* 66:244–47.

With J. E. Nezamis and M. H. Kuizenga. The effects of epinephrine and of adrenal cortex extract upon the survival of eviscerated rats. *Exp. Med. Surg.* 5:379–82.

The resistance of non-adrenalectomized rats to diphtheria toxin with and without adrenal cortical hormone treatment. *Exp. Med. Surg.* 5:375–78.

1948

With J. E. Nezamis. Early effects of denervation upon response of muscle to continuous stimulation. *Proc. Soc. Exp. Biol. Med.* 67:167–69.

The production of experimental glycosuria in the rat. *Recent Prog. Horm. Res.* 2:229–53.

Effect of muscle work upon level of blood glucose in the eviscerated rat. *Proc. Soc. Exp. Biol. Med.* 67:299–301.

With M. C. Prestrud and J. E. Nezamis. Effect of adrenalectomy upon level of blood amino acids in the eviscerated rat. *Proc. Soc. Exp. Biol. Med.* 67:321–22.

Damaging effects of overeating. *Am. Dietet. Assoc.* 24:605–6.

With D. A. Sheppard and W. J. Haines. The effect of adrenochrome upon experimental glycosuria in the rat. *J. Am. Pharm. Assoc. Sci. Ed.* 37:375–77.

With J. E. Nezamis. Effect of nephrectomy in the eviscerated rat upon tolerance for intravenously administered glucose. *Am. J. Physiol.* 153:393–96.

With M. C. Prestrud and C. H. Li. A further study of the essentiality of the adrenal cortex in mediating the metabolic effects of adrenocorticotrophic hormone. *Endocrinology* 43:202–7.

The effect of 11-desoxycorticosterone acetate upon the glycosuria of partially depancreatized rats. *Proc. Soc. Exp. Biol. Med.* 69:329–30.

With M. C. Prestrud. Effect of adrenal cortex upon the urinary nitrogen of rats following adrenalectomy. *Proc. Soc. Exp. Biol. Med.* 69:3366–68.

With J. E. Nezamis. The effect of continuous intravenous infusions of saline upon the survival times of eviscerated and eviscerated-nephrectomized rats. *Exp. Med. Surg.* 6:434–37.

With J. E. Nezamis. Effect of muscle work upon tolerance of eviscerated rat for glucose. *Am. J. Physiol.* 155:15–17.

With J. E. Nezamis. Effect of insulin and glucose upon survival time of eviscerated rats. *Proc. Soc. Exp. Biol. Med.* 69:441–42.

Some studies on factors which influence tolerance for carbohydrate. *Proc. Am. Diabetes Assoc.* 8:3–23.

1949

The technique of evisceration in the rat. *Exp. Med. Surg.* 7:34–36.

With C. H. Li, H. M. Evans, M. C. Prestrud, and J. E. Nezamis. Effect of adrenocorticotrophic hormone upon liver fat and urinary phosphorus in normal force-fed rat. *Proc. Soc. Exp. Biol. Med.* 70:753–56.

With J. E. Nezamis. Effect of epinephrine upon the tolerance of the eviscerated rat for glucose. *Am. J. Physiol.* 156:361–64.

With J. E. Nezamis. Work performance of adrenally insufficient rats given adrenal cortex extract by continuous intravenous injection. *Am. J. Physiol.* 156:365–67.

With J. E. Nezamis. The effect of adrenal cortex extract with and without epinephrine upon the work of adrenally insufficient rats. *Endocrinology* 44:559–64.

With J. E. Nezamis. Tolerance of normal and partially depancreatized rats for insulin. *Proc. Soc. Exp. Biol. Med.* 71:315–17.

Some studies on the role of the adrenal cortex in organic metabolism. *Ann. N.Y. Acad. Sci.* 50:576–95.

With J. E. Nezamis. Effect of Isuprel upon tolerance of the eviscerated rat for glucose. *Proc. Soc. Exp. Biol. Med.* 71:352–53.

With J. E. Nezamis. Infection as a factor causing death in the eviscerate rat. *Proc. Soc. Exp. Biol. Med.* 71:438–39.

A simple means of producing obesity in the rat. *Proc. Soc. Exp. Biol. Med.* 72:604–5.

The metabolic behavior of the eviscerate rat. In *Trans. Eighth Conference of Liver Injury,* pp. 86–114. New York: Josiah Macy, Jr., Foundation.

1950

Physiologic significance of the amorphous fraction of the adrenal cortex. In *Prog. Clin. Endcrinol.* pp. 146–50. New York: Grune & Stratton.

With B. L. Baker and C. H. Li. Increase in glyceride content of

brown fat by treatment with adrenocorticotropin. *Proc. Soc. Exp. Biol. Med.* 73:337–39.

Metabolic effects of adrenal steroids. In *Symposium on Steroid Hormones,* pp. 150–200. Madison: University of Wisconsin Press.

The biologic properties of cortisone: A review. *J. Clin. Endocrinol.* 10:1312–54.

Effect of aspirin upon glycosuria of the partially depancreatized rat. *Proc. Soc. Exp. Biol. Med.* 75:673–74.

With M. C. Prestrud and J. E. Nezamis. Effect of cortisone acetate upon plasma amino acids in the eviscerate rat. *Proc. Soc. Exp. Biol. Med.* 75:801–3.

1951

Control of regeneration of the adrenal cortex in the rat. In *AAAS Symposium on Pituitary—Adrenal Function,* pp. 49–55. Baltimore: The Horn Shafer Co.

With C. W. Castor, B. L. Baker, and C. H. Li. Effect of treatment with ACTH or cortisone on anatomy of the brain. *Proc. Soc. Exp. Biol. Med.* 76:353–57.

With M. C. Prestrud and C. H. Li. Effects of administering adrenocortrophic hormone by continuous injection to normal rats. *Am. J. Physiol.* 166:165–70.

With M. C. Prestrud and J. E. Nezamis. Effects of administering large doses of cortisone acetate to normal rats. *Am. J. Physiol.* 166:171–75.

With J. E. Nezamis. Effect of antibiotics upon survival of the eviscerate rat. *Am. J. Physiol.* 166:349–53.

Parameters of metabolic problesm. *Recent Prog. Hormone Res.* VI: 159–94.

The functional interrelationship of the anterior pituitary and the adrenal cortex. *Ann. Int. Med.* 35:652–72.

With E. H. Morley and J. E. Nezamis. Quantitative biologic activity of $\Delta^{4,6}$-dehydrocortisone as compared to cortisone. *Proc. Soc. Exp. Biol. Med.* 78:220–21.

With J. E. Nezamis and E. H. Morley. Work performance of adrenalectomized rats given cortisone and 17-hydroxycorticosterone by continuous intravenous injection. *Proc. Soc. Exp. Biol. Med.* 78: 79–81.

With G. G. Bole, Jr., B. L. Baker, and C. H. Li. The effect of hypo-

physes hormones on the lipid content of brown adipose tissue. *U. Mich. Med. Bull.* XVII:413–22.

1952

With C. H. Li. Comparison of biologic effects of ACTH protein and ACTH peptide given by continuous injection. *Proc. Soc. Exp. Biol. Med.* 79:128–31.

Tolerance of normal and adrenalectomized rats for cortisone acetate. *Proc. Soc. Exp. Biol. Med.* 79:184–87.

With R. C. Meeks. Comparison of some metabolic and morphologic effects of cortisone and hydrocortisone given by continuous injection to rats. *Am. J. Physiol.* 170:77–80.

With J. E. Nezamis and E. H. Morley. Effect of the continuous intravenous administration of corticotropin upon the work output of hypophysectomized rats. *Am. J. Physiol.* 171:378–80.

The role of the adrenal cortex in homeostasis. *J. Endocrinol.* 8: xxiii–xxxvii.

1953

With D. F. Beary and A. Purmalis. Comparison of effect of progesterone and 11-ketoprogesterone upon glycosuria of partially depancreatized rat. *Proc. Soc. Exp. Biol. Med.* 82:416–19.

With J. E. Nezamis and R. C. Meeks. Effect of adrenal cortical extract upon work output and glucose tolerance of adrenalectomized-eviscerate rat. *Proc. Soc. Exp. Biol. Med.* 83:537–39.

With J. E. Nezamis and E. H. Morley. Failure of certain vitamins to affect the survival of the eviscerated rat. *Proc. Soc. Exp. Biol. Med.* 83:602–3.

With J. E. Nezamis and L. M. Humphrey. Effect of adrenal cortical extract and steroids upon glucose tolerance of eviscerate rats. *Proc. Soc. Exp. Biol. Med.* 84:45–47.

With D. F. Beary and A. Purmalis. Effect of continuous injection of epinephrine upon the glycosuria of partially depancreatized rats. *Proc. Soc. Exp. Biol. Med.* 84:112–14.

With H. B. Coutinho and B. L. Baker. Effect of continuous injection of epinephrine on the adrenal cortex and anterior hypophysis. *Proc. Soc. Exp. Biol. Med.* 84:1137–40.

With J. E. Nezamis and L. M. Humphrey. Absence of hyperglycemic effect of glucagon in the eviscerate rat. *Proc. Soc. Exp. Biol. Med.* 84:232–33.

With R. C. Meeks and D. F. Beary. Time-response effect of cortisone upon liver glycogen in the rat. *Proc. Soc. Exp. Biol. Med.* 84:239–40.

With R. C. Meeks and D. F. Beary. Level of liver glycogen in rats steroid diabetes. *Proc. Soc. Exp. Biol. Med.* 84:334–36.

The relationship of the adrenal cortex to the manifestation of certain metabolic changes and to certain diseases. *Am. Pract. Dig. Treat.* 4:628–35.

With D. F. Beary and A. Purmalis. Comparison of the effect of 11β-hydroxyprogesterone and of 11β, 17 α-dihydroxyprogesterone upon the glycosuria of the partially depancreatized rat. *Metabolism* 2:510–12.

Some studies on experimental diabetes. A review. *Lancet* 73:470–78.

With B. L. Baker. A consideration of the relationship of experimentally produced and naturally occurring pathologic changes in the rat to the adaptation diseases. *Recent Prog. Hormone Res.* VIII:143–69.

With B. L. Baker. In *Physiological and Therapeutic Effects of Corticotropin (ACTH) and Cortisone.* Springfield: Charles C Thomas.

The effect of adrenal steroids upon muscle work. *Ciba Found. Colloq. Endocrinol.* 5:175–85.

1954

With D. F. Beary and A. Purmalis. Effect of continuous injection of glucagon upon glycosuria of the partially depancreatized rats. *Proc. Soc. Exp. Biol. Med.* 85:432–33.

With B. L. Baker and C. H. Li. Effect of corticotropin and cortisone and globule leucocytes of rat. *Proc. Soc. Exp. Biol. Med.* 85:635–37.

Psychological barriers in research. *Am. Sci.* 42:283–93.

Education for research: An editorial. *J. Clin. Endocrinol. Metab.* 14:588–89.

Endocrine stress and aging. In *Symposium on Problems of Gerontology,* pp. 120–29. New York: The National Vitamin Found., Inc.

Technic of repeated partial hepatectomy in the rat. *Proc. Soc. Exp. Biol. Med.* 87:251–53.

Permissibility of hormone action. A review. *Acta Endocrinol.* 17:172–86.

1955

With G. Torralba and V. Flores. Comparative effects of muscle work and insulin upon plasma amino acids in eviscerated rats. *Proc. Soc. Exp. Biol. Med.* 89:625–26.

Hormonal control of amino acid metabolism. A discussion. *Fed. Proc.* 14:705–6.

With V. Flores and G. Torralba. Effect of epinephrine upon level of plasma acids in the eviscerate rat. *Proc. Soc. Exp. Biol. Med.* 90:217–18.

Effect of endocrine glands on normal muscle work. Am. J. Med. 19:724–28.

1956

Some questions relating to the role of the adrenal cortex in the etiology of disease. In *Fifth Annual Report on Stress, 1955–1956,* eds. Hans Selye and Gunnar Heuser, pp. 161–68. New York: MD Publications, Inc.

The role of the adrenal cortex in homeostasis. *Pediatrics* 17:407–13.

With V. Flores and G. Torralba. Effect of tumors on level of plasma amino acids on eviscerate rats. *Proc. Soc. Exp. Biol. Med.* 91:168–69.

Experimental steroid diabetes. *Diabetes* 5:187.

With T. L. Altamero, Jr., and V. Flores. Weights of tumors in overfed rats. *Cancer Res.* 16:437–39.

Naturally Occurring Pathology in the Aging Rat. New York: Academic Press.

1957

With B. L. Baker. Histology and regenerative capacity of liver following multiple partial hepatectomies. *Proc. Soc. Exp. Biol. Med.* 95:813–15.

With D. Price. Androgenic effects of autotransplants of adrenals in the accessory reproductive glands of adult castrated rats. *Rev. Suisse Zool.* 64:743–56.

The physiologic role of the pituitary and the adrenal glands in health and disease. In *Surgery, Principles and Practice,* ed. J. Garrott Allen, section 1. Philadelphia: J. B. Lippincott Co.

1958

Principles of Research in Biology and Medicine. Philadelphia: J. B. Lippincott Co.

1959

Current status of adrenocortical research. *Am. Sci.* 47:413–26.

With G. F. Wilgram. Renal cardiovascular pathologic changes in aging female breeder rats. *AMA Arch. Pathol.* 68:690–703.

The training of the investigator. In *The Clinical Evaluation of New Drugs*, eds. S. O. Waife and A. P. Shapiro, pp. 100–109. New York: Paul B. Hoeber.

Experimental diabetes. In *Diabetes*, ed. R. H. Williams, pp. 297–308. New York: Paul B. Hoeber.

Effect of estrogen on liver glycogen in adrenalectomized rats. *Proc. Soc. Exp. Biol. Med.* 100:439–40.

1960

Role of the adrenal cortex in pathogenesis. *Clin. Endocrinol.* I:363–72.

With W. A. J. Crane and G. F. Wilgram. The role of the adrenal cortex in the aetiology of various diseases. *Scott. Med. J.* 5:437–47.

Living philosophy. A lecture presented to the Chicago Sunday Evening Club.

1961

The role of the adrenal cortex in the etiology of disease. *J. Okla. State Med. Assoc.*, pp. 107–12.

With David J. Ingle. The effect of some stressors on symptoms of cortisone overdosage. *J. Okla. State Med. Assoc.*, pp. 113–17.

Editorial: Science versus value commitments. *Perspect. Biol. Med.* 4:391–92.

The relationship of adrenal cortex functions to disease. *Am. J. Proctol.* 12:245–52.

Studies on the role of hormones in growth, vigor and disease. In *The Scientific Contributions of the Ben May Laboratory for Cancer Research*, pp. 25–39. Chicago: University of Chicago Press.

Testing claims to knowledge in biology and medicine. *Perspect. Biol. Med.* 5:65.

1962

Control and exploration of animal variables in drug research. Part II of the Symposium on Clinical Drug Evaluation and Human Pharmacology. *Clin. Pharm. Ther.* 3:242.

Great teachers for our university. *University of Chicago Magazine*, May 1962, p. 3.

Uses of efficiency in science and education. *Perspect. Biol. Med.* Spring.

With G. Williams-Ashman. Toxicity of ammonium acetate in rats. *AMA Arch. Pathol.* 73:343–51.

The search for causes of diseases. In *On Cancer and Hormones.* Chicago: University of Chicago Press.
Editorial: Individual differences. *Perspect. Biol. Med.* Summer.
Editorial: The agressive minority, the passive majority. *Perspect. Biol. Med.* Autumn.
Editorial: To support research. *Perspect. Biol. Med.* Winter.

1963

Editorial: What are the biological bases of superiority? *Perspect. Biol. Med.* Winter.
The care and treatment of animals. *Perspect. Biol. Med.* Winter.
George did it. *Perspect. Biol. Med.* Spring.
Life and Disease: New Perspectives in Biology and Medicine. New York: Basic Books.
I Went to See the Elephant. New York: Vantage Press.
A Dozen Doctors. Chicago: University of Chicago Press.
Comments on the teachings of Carleton Putnam. *Mankind Q.* 4:19–34.

1964

Editorial: The biology of freedom. *Perspect. Biol. Med.* 7:141–42.
Exacerbation of glycosuria by partial hepatectomy in the partially depancreatized rat. *Proc. Soc. Exp. Biol. Med.* 116:110–12.
With W. A. J. Crane. Tritiated thymidine uptake in rat hypertension. *Arch. Pathol.* 78:209.
With W. A. J. Crane. Effects of stressors on symptoms of corticoid overdosage. *Arch. Pathol.* 77:358.
From A to F. *The Pharos of Alpha Omega Alpha* 27:77ff.
Racial differences and the future. *Science* 146:375–79.

1965

With W. A. J. Crane. Cell proliferation in adrenal-regeneration hypertension. *Arch. Pathol.* 79:169–76.
Comparison of pancreatic and steroid diabetes in respect to tumor growth and glycosuria. *Diabetes* 14:93–95.
Aids to Negro advancement. *J. Hum. Relations* 13:40–48.
With W. A. J. Crane, and L. D. Dutta. Cell proliferation in the rat pituitary. *Proc. Soc. Exp. Biol. Med.* 119:167–69.
The 1964 UNESCO proposals on the biological aspects of race: A critique. *Perspect. Biol. Med.* Spring.

Individuality as a factor in integration. *The School Review,* Vol. 73, No. 4.

Effect of Jensen tumor on pancreatic diabetes in nonadrenalectomized and adrenalectomized rats. *Proc. Soc. Exp. Biol. Med.* 120:225–28.

Living philosophy—Evolution as a parameter of existence. *The Pharos of Alpha Omega Alpha* 28(4):125ff.

1966

The biological future of man. *Chicago Today,* Vol. 3, No. 2, Spring.

Scientific and ethical responsibilities associated with the use and care of animals. *Fed. Proc.*, Vol. 25, No. 5, September–October.

1967

Effects of insulin on excretion of nitrogen in normal, depancreatized, and steroid-diabetes rats. *Diabetes* 16:18–20.

Effects of cortisone and insulin on tumor weights, urinary glucose and nitrogen in rats. *Proc. Soc. Exp. Biol. Med.* 125:28–29.

On average biological differences in man. *The Columbia University FORUM,* Vol. X, No. 1, Spring.

Editorial: The need to study biological differences among racial groups: Moral issues. *Perspect. Biol. Med.* Vol. 10, No. 4, Summer.

Discussion: Endogenous factors influencing host-tumor balance. Chicago: University of Chicago Press.

1968

Scientific study of possible racial difference in intelligence asked. *Pediatric News* 2:3–5.

Living philosophy. In *Reflections on Biologic Research,* pp. 103–8. St. Louis: Warren H. Green, Inc.

The need to investigate average biological differences among racial groups. In *Science and the Concept of Race,* pp. 113–21. New York: Columbia University Press.

Editorial: Biological malignancy and social malignancy. *J. Am. Med. Assoc.* 203:290.

Uncertainty as a parameter of ethics. *Zygon* 3:323–34.

Biomedical bases of social problems. *The Mayo Alumnus* 5:2–5.