

Charles Raymond Greene (1901-1982)

Charles Raymond Greene studied hormones and the effects of environmental conditions such as high-altitude on physiology in the twentieth century in the United Kingdom. Green researched frostbite and altitude sickness during his mountaineering expeditions, helping to explain how extreme environmental conditions effect respiration. Greene's research on hormones led to a collaboration with physician Katarina Dalton that culminated in the development of the theory that progesterone caused premenstrual syndrome, a theory that became the basis for later research on the condition. In his later career Greene formed the Thyroid Club of London that brought together specialists in the emerging field on endocrinology. Greene's research on progesterone and thyroid helped researchers study how the endocrine system functions in women's reproductive health.

Charles Raymond Greene was born on 17 April 1901 in Berkhamsted, England, to Marion Raymond Greene and Charles Henry Greene. He descended from a lineage of bankers, statesman, and founders of the Greene King Brewery Company. Greene was one of six children, including his brother, Graham, who was born in 1905 and became a novelist who influenced Raymond's own writing career. As a child, Greene often went on outdoor excursions with his father until the age of sixteen when he attended Berkhamsted School in Berkhamsted, England. There he listened to a lecture by Ashley Adams, an expert rock climber, whom he approached after the lecture to express his interest in climbing.

Greene and Adams began to correspond and plan climbing expeditions together. During his adolescence, Greene, his eldest sister Molly, and Adams went on an expedition to Pillar Rock in the Lake District mountain range in Northwest England. After a rope malfunctioned during climbing, Greene saved the lives of both his sister and Adams. That year, Greene won a scholarship to Pembroke College at the University of Oxford in Oxford, England. During his undergraduate career, Greene joined the University of Oxford Mountaineering Club with which he further explored the Lake District and the Alps in Switzerland. Following his undergraduate education, Greene continued to attend the University of Oxford to study medicine.

In 1927 Greene graduated from the University of Oxford with a degree in medicine. That year Donald Paterson, a pediatrician at the Westminster Children's Hospital in Westminster, England, offered him a pediatric position. Paterson secured the position for Greene with an endowment from Wander, a baby food manufacturer based in England. In that position, Greene served as a surgeon, house physician for children, and resident obstetric assistant. However, the endowment paid 200 pounds per year, an amount less than what Greene wanted to maintain the financial wellbeing of his extended family following his father's retirement. Therefore, Greene left the appointment at Westminster Hospital and joined the general practice of a physician whom he had befriended at the University of Oxford. For the following ten years, Greene worked in general practice, treating patients in the neighborhood slums of St. Ebbes's and St. Thomas's in Oxford, England.

In addition to climbing for sport, Greene went on mountaineering excursions to study the effects of altitude on human physiology. Greene focused specifically on respiration, recuperation, and frostbite from high altitude. In 1931, Greene served as a medical officer on mountain climber Frank Smythe's expedition to Kamet, the second highest mountain in India. He was a team member and medical officer for the excursion to help climbers in case they suffered from altitude sickness or became injured. That year Greene published the article "Oxygen and Everest," and in 1932, wrote a chapter in a Smythe's book Kamet Conquered titled "Medical Aspects of High Climbing." Prior to these publications, there was limited data available on how the body physiologically coped with high-altitudes, and his findings provided information for how to approach acclimatizing to different

altitudes, based on measuring levels of carbon dioxide respired.

In 1933, Greene was the chief medical officer for an expedition to Mount Everest, during which he performed dental extractions, surgeries, and studied the effects of high altitude on respiration by collecting alveolar tissue samples from the lungs of climbers. Prior to the excursions Greene had improved the design of oxygen kits used by climbers, and he tested the new design during the ascent. A year after that expedition, Greene published "Observations on the Composition of Alveolar Air on Everest," which cautioned against the use of additional oxygen during a climber's ascent. However, according to historian George W. Rodway, Greene's aversion to using supplemental oxygen might have been less grounded in his findings than in his and his fellow climbers' purist view that climbing should be done without assistance.

Following the expedition in 1935, Greene married Eleanor Craven and together they had two children. Greene's medical focus shifted from general and mountain medicine to endocrinology, the study of hormones. In 1937, Greene became a clinical assistant at the Westminster Hospital in Westminster, England. However, his work was interrupted as a result of World War II, during which he taught medicine to intelligence agents being sent to the front. Despite the war, Greene continued his medical research, drawing upon his experience mountaineering and treating soldiers to publish the paper, "The Prevention and Treatment of Frostbite" in 1942. In the paper, Greene likened frostbite to trench foot, a condition suffered by soldiers engaged in trench warfare whose feet were continually exposed to cold wet mud. He recommended preventative strategies that included alternative foot dressing techniques.

After the end of the World War II, Greene began working as a physician at the Metropolitan Free Hospital and the Royal Northern Hospital, both in London, and in the thyroid clinic at the New End Hospital in Hampstead, England, where he focused on endocrinology. In 1949, Greene published a review paper on the therapeutic use of androgens for several conditions suffered by both men and women. Androgens are male sex hormones that promote male secondary sex characteristics like hair growth and stimulate production of the hormone testosterone, found in higher concentrations in men than in women. Most of the conditions Greene addressed in the paper resulted from an androgen deficiency to which he suggested the supplementation of appropriate hormones, such as testosterone as a treatment for testosterone deficiency.

On 16 November 1950, Greene, along with sixteen other leading endocrinologists in England, inaugurated the Thyroid Club of London. Interest in the organization gradually increased from specialists around England as well as internationally. At the twenty-fifth meeting in 1957, Greene proposed the organization should include more physicians from outside the London area. In 1951, Greene published a book titled *The Practice of Endocrinology* in which he examined the newest theories and therapies circulating within the field, touching upon the hypothesized connection between hormones and migraine headaches.

In 1953, Katharina Dalton, a general practitioner in London contacted Greene because of his expertise on sex hormones and migraines. They collaborated on a paper titled "The Premenstrual Syndrome." In the paper they defined a cluster of symptoms including bloating, headache, fatigue, anxiety, and irritability commencing one to two weeks before the menstrual period and ending upon its onset. Dalton and Greene's paper postulated that the condition was caused by a deficiency in progesterone, a female sex hormone responsible for the development of mammary glands and preparation of the lining of the uterus for the potential implantation of an embryo during pregnancy. Progesterone levels normally fluctuate throughout the menstrual cycle, decreasing days before onset of the period and becoming elevated during pregnancy. Prior to Greene and Dalton's paper, researchers hypothesized that the symptoms of PMS resulted from fluid retention caused by an excess of the female sex hormone, estrogen.

After working with Dalton researching the hormonal cause of PMS, Greene shifted his focus from sex hormones to the thyroid hormone. In 1954, The Royal College of Physicians in London elected Raymond as a fellow due to his contributions to the field of endocrinology. In 1958, Greene studied hypothyroidism, a condition in which the thyroid gland in the neck does not produce enough thyroid hormone to maintain normal bodily functions, and hyperthyroidism, when the body produces thyroid hormone in excess. The thyroid hormone circulates in the bloodstream in two forms, tri-

iodothyronine and thyroxine, both of which are necessary for regulating the body's metabolism and calcium balance. In 1958, together with Helen Farran, a biophysicist from the New End Hospital in London, Greene published "Physiological Activity of D-Thyroxine." In that paper, Farran and Green identified two chemically identical thyroid hormones (L-thyroxine and D-thyroxine) that metabolized differently. They studied how each chemical affected hyperthyroidism and hypothyroidism. Farran and Greene found that D-thyroxine effectively led to the remission of hyperthyroidism, the overproduction of thyroid hormone that characterizes conditions like Grave's disease.

In his later career, Greene wrote several books including *Human Hormones* in 1970, his own autobiography *Moments of Being: The Random Recollections of Raymond Greene* in 1974, and *Current Concepts in Migraine Research* in 1978. Greene died in December of 1982.

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