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One Hundred Years of Insulin

The 1923 Nobel Prize in Physiology or Medicine was awarded jointly to Canadian physician Frederick Grant Banting (1891-1941) and Scottish biochemist and physiologist John James Macleod (1876-1935) "for the discovery of insulin". It was a remarkable finding since diabetes mellitus was an untreatable and often lethal disease until then. Much has been written about Banting and Macleod's breakthrough research conducted at the University of Toronto starting in November 1920, including the key roles played by their trustworthy assistants, medical student Charles Best and biochemist James Collip. On the other hand, much less has been written about the pioneering research of Romanian physiologist Nicolae Paulescu (1869-1931), whose work on the metabolic effects of canine pancreatic extracts predates that of Banting and Macleod but was interrupted by World War I. Should Best, Collip, or Paulescu have also shared the Nobel Prize?

Notwithstanding some well-known controversies regarding their Nobel prize, it is remarkable that Banting and Macleod were honored in such a way based on their *first* nomination and less than two years after the first publications describing the hypoglycemic action of purified pancreas extracts on blood sugar appeared early in 1922.

The structural elucidation of insulin is also a fascinating story. The British biochemist Frederick Sanger (1918-2013), the only scientist to have twice won the Nobel Prize in Chemistry (in 1958 and 1980), established the amino acid sequence (*i.e.,* the primary structure) of the two polypeptide chains of bovine insulin in the early 1950's.

Later on, in 1969, the renowned British chemist Dorothy Crowfoot Hodgkin (1910-1984) determined the molecular structure of insulin using X-ray crystallography, five years after receiving the Nobel Prize in Chemistry "for her determinations by X-ray techniques of the structures of important biochemical substances", which included cholesterol, penicillin, and vitamin B_{12}.

The centennial of the discovery of insulin has been commemorated so far this year by the postal services of five countries, namely Switzerland, Canada, North Macedonia, Pakistan, and Brazil, and the postage stamps from the first four are illustrated in this note. The Swiss stamp is perhaps the most visually appealing and depicts a ribbon diagram of the A- and

B-chains of amino acids that make up insulin, whereas the one from Pakistan features Banting, Best, and part of the front page of the 22 March 1922 edition of *The Toronto Daily Star* that announces the discovery of insulin ("Toronto doctors on track of diabetes cure").

While there is no actual cure for diabetes, it is today an easily treatable disease and there are multiple organizations that organize awareness campaigns to promote various diagnostic and therapeutic options. And, since 1991, the International Diabetes Federation and the World Health Organization celebrate World Diabetes Day each year on November 14th, the birthday of Sir Frederick Banting. It is finally worth noting that this past August, a special symposium entitled "Celebrating 100 years of Insulin: Preserving and Sharing the Memory of Chemical Past" was organized by Brigitte Van Tiggelen, Christopher Rutty, and Elizabeth Neswald during the IUPAC Congress, on August 16th.