August Krogh and Gas Exchange

JV Pai-Dhungat

S hack August Krogh (1874-1949) was born in Grenaa, Eastern Denmark. He entered the University of Copenhagen (1893) to study medicine but soon devoted himself to zoology. After passing zoology examination he became Christian Bohr’s assistant (1897), whose interest in respiratory and blood gas physiology left a life time impression on him. In 1908, he was made Professor of Zoo physiology at the University of Copenhagen.

Krogh’s scientific work embraces a number of different fields. As a young student he started experiments in hydrostatic mechanism of larva and worked out methods for microscopic analysis of gas contained in its air bladder (1896). He took part in an expedition to North Greenland, where he studied the CO2 tension and the O2 content in the streams and sea water, thus surveying H2CO3 and O2 in Oceans and in fresh water. This led to important discovery that ocean water played an important role in controlling CO2 and carbonic acid in the atmosphere. During the study he also set out principles of tonometric measurement of dissolved gases which was later applied in physiology.

As Bohr’s assistant he became interested in problems connected with living organisms. Krogh’s dissertation (1903) contained a study of gas exchanges in the frog. He observed that while skin respiration was relatively constant, great variation occurred with regard to lung respiration. Krogh doubted his chief’s assumption that O2 was actively secreted by alveolar membrane. With his wife Marie Krogh, he subjected the whole question of nature of gas exchange in the lungs to a new examination. For this purpose he constructed his well known micro-tonometer (1904) based on principle of gas tension equalization using CO as a foreign gas, and obtained accurate readings required for the measurement and interpretation of blood gases and their transport, rejecting Bohr’s theory of active O2 secretion.

With Bohr and Hasselbach, he described the influence of CO2 tension on oxyhemoglobin dissociation curve, later known as “Bohr effect”. JS Haldane later found that oxygen tension also influenced this curve. Most import is Krogh’s study of capillaries during rest and work in which he arrived at the conclusion that during muscular work, capillaries which had remained closed earlier, now opened up, enlarging the surface from which oxygen could diffuse.

Krogh designed precise instruments like recording spirometer, pipettes and advanced micro-devices, for determination of basal metabolism, and a bicycle ergometer, to study physical activity in man. The changes observed by him during physical activity were of considerable merit. He demonstrated a tenfold rise in the pulmonary blood flow during muscular work, compared to resting lung circulation and described the full response of capillaries and blood gases as “Call for oxygen”.

Throughout his rich career, Krogh’s experimental studies not only embraced study on man, but also on lower life(vertebrates and insects). He was awarded Nobel Prize in Physiology and Medicine in 1920.

Krogh’s wife was diagnosed with type 2 diabetes in 1921. Hearing about insulin invention he obtained Macleod and Banting’s permission to set up insulin manufacturing facility in Copenhagen. Within months Mary Krogh was among thousands of diabetics using insulin. The factory is now pharmaceutical giant Novo Nordisk.