EUGENE MARKLEY LANDIS (Fig. 1) was born in New Hope, Pennsylvania, in 1901. He received MD and PhD degrees from the University of Pennsylvania in 1926 and 1927, respectively. While still a medical and graduate student, he undertook a research project that began a series of outstanding contributions to the physiology of the minute blood vessels. One of his professors suggested that he try microinjecting synthetic dyes of known molecular size and configuration into capillaries in living animals. Their intense colors might make it possible to evaluate their permeation through the capillary walls. Landis carried this project to a spectacularly successful and fruitful conclusion. The novel techniques he developed and the important information he obtained with them opened an entirely new approach to the study of the physiology of the minute blood vessels. They remain the basis for much of the research done on microcirculation today (for example, Refs. 1, 6, 8).

Two papers dating from this period stand out as landmark contributions (2, 3).

The first of these papers (2) describes a new method to measure blood pressures in microvessels of the frog mesentery and the novel results Landis obtained by this method. To inject dye solution into a vessel, pressure in the micropipette had to be greater than the pressure in the vessel. If the pressure was lower, the dye front moved back into the pipette tip as blood plasma flowed in. Landis realized that when pressure in the pipette was just equal to pressure in the micropunctured vessel, the dye front remained stationary in the pipette tip. Using this method, he demonstrated a continuous fall of blood pressure from arterioles to capillaries to venules. Pressures in true capillaries averaged 14.4 cmH2O and in venous capillaries 10.1 cmH2O. Microvascular pressures and blood flows were increased by arteriolar vasodilation and decreased by vasoconstriction.

The second paper (3) has two parts. Part I is about the project initially suggested to Landis. It deals with his attempts to measure capillary and venular permeability to certain dyes in relation to their molecular weights and to capillary pressure. Dyes were microinjected into a vessel, and their first appearance outside was timed. The results of this part of the study were inconclusive because many of the dyes became bound to plasma proteins and were only partly free in plasma. Many years later, when dyes of known binding characteristics were available and photometric measurement techniques had been developed, a new generation of microcirculatory physiologists was able to exploit this approach to studying solute permeabilities.

The second part of this paper is about the influence of capillary blood pressure on transcapillary fluid movement. Again, Landis’ approach was novel and ingenious. He had observed that if a capillary was blocked by a blunt microrod, pressure rose toward arteriolar pressure on the upstream side of the block and fell toward venular pressure downstream of the block. Because there was no blood flow through the blocked capillary, any movement of the trapped red blood cells toward the block indicated outward fluid movement through the cap-
illar wall (“filtration”), and any movement away from the 
block showed fluid movement into the capillary (“absorption”).
A plot of individual measurements of filtration or absorption 
 rates in many capillaries against the corresponding capillary 
 pressures showed a narrow scattering of points about a straight 
line, with an intercept of zero flow at a capillary pressure of 
11.5 cmH2O.

According to Starling’s hypothesis of transcapillary fluid 
balance by opposing actions of hydrostatic and colloid osmotic 
forces (9), the intercept of this line defines the effective 
osmotic pressure of the plasma proteins. The slope of the line 
is a measure of the permeability of the capillaries to ultrafiltered 
fluid (\(k_c\), capillary filtration coefficient). Consistent with 
Starling’s hypothesis, the average zero-flow pressure observed 
by Landis was within the range of frog plasma colloid osmotic 
pressures measured by other investigators (10–12 cmH2O). 
The near equality of hydrostatic and colloid osmotic forces 
showed that normal capillary walls were nearly impermeable to 
plasma colloids. In capillaries injured by application of alcohol 
used on the capillary wall (\(\Delta \Pi_{\text{col}}\), and any movement away from the 
“filter”) would increase, shown that permeabilities to plasma 
colloids and to filtered fluid were increased. The significance of 
these observations for future research was immense. They 
demonstrated how transcapillary fluid movement is related to 
capillary pressure and defined capillary permeabilities to filtered 
fluid and to plasma colloids in precise, measurable terms.

After he had obtained his MD and PhD, Landis continued to 
be a leader of research in the field of cardiovascular physiolo-
gy. He remained at the University of Pennsylvania in research 
and faculty positions until 1939, with an interruption from 
1929 to 1931 as a Guggenheim Fellow working with August 
Krogh in Copenhagen and Thomas Lewis in London. During 
this period, he made direct measurements of microvascular 
presures in human skin in normal individuals and in patients 
with Reynaud’s disease and developed indirect methods of 
measuring capillary filtration coefficients in human subjects.

In 1939, Landis was appointed Chair of the Department of 
Medicine at the University of Virginia where he continued his 
cardiovascular research. In 1943, he moved to Harvard Medi-
cal School as George Higginson Professor and Chair of the 
Physiology Department, succeeding Walter B. Cannon. He 
conducted research on factors affecting capillary permeability 
and on the pathophysiology of hypertension. During World 
War II, he served on the Committee on Aviation Medicine in 
Washington, DC. After the war, he collaborated with col-
leagues on several important reviews of research in cardiovas-
cular physiology. Landis played a leading role in the develop-
ment and expansion of biomedical science after World War II. 

His scientific publications are numerous and include research 
reports, topical reviews, and book chapters, as well as lectures 
and essays. Landis also served on the editorial boards of 
important scientific journals. He was active in the affairs of the 
American Physiological Society (President, 1952–1953) and 
the American Society for Clinical Investigation (President, 
1943), as well as other professional societies.

Professor Landis contributed to the education and career 
development of many young physiologists, including the writer 
of this essay. His 1964 essay “APS and Youth” (5) looks back to 
the excitement of his first oral presentation at a meeting of 
the American Physiological Society. Landis concluded his 
essay, “All of this is simply to say that in this Society of ours, 
youths of all ages are offered a whole span of graded chal-
enges and opportunities to make an entire lifetime in physi-
ology especially rewarding.”

Landis continued to work on the physiology of hypertension 
until his retirement from the Chair at Harvard in 1967. He then 
returned to the region where he grew up and until 1971 was an 
Adjunct Professor of Biology at Lehigh University in Bethle-
hem, Pennsylvania. It was at Lehigh that he completed his last 
research project, a study of the osmotic effects of permeating 
solutes in frog capillaries. He died in 1987.

Landis’ chapter on the capillary circulation in Richardson 
and Fishman’s book on the history of cardiovascular physiol-
gy (4) and C. C. Michel’s obituary of Prof. Landis, which 
includes his description, in a letter to Dr. Michel, of how he got 
started in research on capillaries (7), are recommended reading.

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