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Koller D, Mayer A M, Poljakoff-Mayber A & Klein S. Seed germination.
Annu. Rev. Plant Physiol. 13:437-64, 1962.
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This paper reviewed the regulation and metabolism of seed germination. It discussed physiological, metabolic, enzymatic, hormonal, and developmental aspects of the process and tried to relate these to the ecology of seeds. [The *SCI*® indicates that this paper has been cited in over 140 publications.]

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The four of us were introduced to the problem of seed germination by our colleague and mentor, Michael Evenari. We became fascinated by the problem presented by the transition of a plant embryo, whose basic rate of metabolism is so low as to be almost immeasurable, into a vigorous, rapidly growing seedling, provided it was given the right environment. This change involves water uptake and a change from hetero- to autotrophic nutrition. Moreover, the embryo also has the capacity to retain the potential for germinating for several years, albeit not always at the same level. In some cases, the potential increases with time (loosely described as "after-ripening"), while in other cases it decreases with time ("ageing"). Under certain environmental conditions, the imbibed seed enters a state of deeper suspended animation (termed "secondary dormancy") without loss of viability, i.e., the potential for eventual germination.

In the course of germination, the systems involved in cell expansion become operative, concomitantly with the metabolic pathways that supply the necessary machinery, metabolites, substrates, energy, and growth regulators. However, rehydration of the embryonic tissues, as well as the storage tissues and the enveloping structures of the dispersal unit, is a prerequisite for the initiation of this transformation, and this process follows distinctive time-courses, sequences, and pathways. It is highly dependent on water relations at the soil-seed interface.

Whereas in some seeds, germination requires only suitable rehydration, aeration, and temperature, in others, the process is initiated only by a rather precise environmental event, or combination of factors (e.g., seasonal or diurnal temperature alternations, light of specific spectral quality and duration, specific water relations, atmospheric composition, and so on).

Study of germination has led to various avenues of exploration. The "release from dormancy" has inspired the search for some "master reaction" whose activation is a prerequisite to the initiation of all others, some simultaneously, others sequentially. The environmental control of germination has also led to the concept of "germination-regulating mechanisms," which had evolved in many species as a means of restricting germination to the environmental niche, in space as well as in time, and which offer a high probability for seedling establishment and thus the survival of the species. That the germinating seedling must pierce its enveloping structures, necessitating the development of sufficient thrust to overcome the mechanical resistance of these coats, led to the study of the biophysics of growth in germination. Finally, the environment under which the seeds had developed and matured on the mother plant often has profound effects on its subsequent germination responses, and these conditions, too, merited study.

We had, at the time of writing, different scientific approaches and attitudes to the study of seed germination. We also had different temperaments and philosophical insights, but apparently the admixture when we sat down to write the paper was just right, and our personal attitudes managed to mesh. Three of us are continuing, among other things, to work in the area of seed germination, and we miss our colleague, S. Klein, whose untimely death is sorely felt.

Some more recent work in germination is cited below.[1-5]

1. **Kahn A A**, ed. *The physiology and biochemistry of seed dormancy and germination.* Amsterdam: North-Holland, 1977. 447 p.
2. **Koller D & Hadas A.** Water relations in seed germination. (Lange O L, Nobel P S, Osmond C B & Ziegler H, eds.) *Physiological plant ecology II: water relations and carbon assimilation.* Berlin: Springer-Verlag, 1982. p. 402-31.
3. **Mayer A M & Poljakoff-Mayber A.** *Germination of seeds.* London: Pergamon Press, 1982. 212 p.
4. **Mayer A M & Marbach I.** Biochemistry of the transition from resting to germinating state in seeds. *Prog. Phytochemistry* 7:95-136, 1981.
5. **Bewley J D & Black M.** *Physiology and biochemistry of seeds in relation to germination.* Berlin: Springer-Verlag, 1978-1982. 2 vols.