May 31,1946

Prof. Gilbert M. Smith,
Biology Dept.,
Stanford University,Calif.

Dear Professor Smith:

It is about ten years that I have been teaching morphology of angiosperms by the use of the notes that were prepared by you for apparently a similar course. (I received these notes from Dr. Borthwick.) Perhaps you remember that I asked you once whether you contemplated converting these notes into a book. Your answer was definitely negative.

I wish to return to this question. My classes are enlarging and I do need a more modern text than that of Coulter and Chamberlain. (The latter is not ever to be had, as you probably know.) Could you possibly be interested in the following proposition.

I would revise your notes so as to bring them up to date; illustrate them by a few line drawings; submit them for your approval; then publish them by the mimeograph process as Dr. Foster has been doing for years with his "Practical Plant Anatomy." The book could be named " A text of the morphology of angiosperms" by G.M.Gilbert and K. Esau.

Please let me know if you are at all interested in such a proposition. If the venture were to prove successful, the text could be converted later into a regular book. As a matter of fact, the Wiley people are interested in such a book right now.

Sincerely yours,

Katherine Esau
Associate Botanist

KE:G

June 6,1946

Dr. Gilbert M. Smith,
Stanford University
School of Biological Sciences,
Stanford University, Calif.

Dear Dr. Smith:

Thank you for your kind reply of June 5. It is very generous of you to offer turning over the manuscript to me, but frankly, I would have felt much more secure if the eventual publication would have come out under joint authorship. Of course, I understand your attitude and agree that books should be written by people doing research in the field covered by the book. Unfortunately, I too am not doing any research in morphology of angiosperms (the work on guayule was a sort of a "strange interlude") and was hoping, for years that someone else would write the book. Since this is not happening, I am trying to find another way out. Publishing in a mimeographed form would seem to be a less serious venture than writing a regular book and this is the reason I thought of it.

Now that you suggest my writing the book alone, I would like to think the matter over. In the meantime, I would appreciate having your original notes, which I hope I may keep for quite a long time. If I decide to make the revision,I would like to start working on it in the spring of 1947 when I shall teach this course again.

Please remember me to Mrs. Smith. I often recall, with pleasure, my visit at your home.

Sincerely yours,

Katherine Esau

KE:G

STANFORD UNIVERSITY

SCHOOL OF BIOLOGICAL SCIENCES

STANFORD UNIVERSITY, CALIFORNIA

June 5
1946

Dear Doctor Esau:

I would like to answer you letter of May 31st by beginning with a little history and personal philosophy. I have always written lecture notes in full so that I could make a comprehensive review of material before the lecture hour. I did this for the course on angiosperms I gave at Wisconsin. When I came to Stan ford I completely rewrote my lectures on this subject and did it in book form with the ultimate expectation of making them into a book. Shortly after I did this in 1926 I became convinced that one should not write a book on a subject where he had not done research in at least one phase. Since this is the case with me with respect to the angiosperms I abandoned all idea of working up these lectures for publication in book form.

~~The~~ In 1930 (?) Dr. Wiggins took over the course in angiosperms. As a result nothing has been done towards bringing my notes up to date for more than 15 years. This being the case it would mean an almost complete rewriting, though perhaps the general framework could be preserved. I am perfectly willing to turn the manuscript over to you and let you do with it as you see fit. I think that you will revise the material so extensively that it will be far more your material than mine. Thus I think that you should be the sole author and it should not appear as a joint publication. Whatever credit is due me could be given in a preface.

I do hope that you go ahead with the project and that it is ultimately published in book form. A book on this subject is one where the author will have no difficulty in finding a publisher.

Instead of working from the Borthwich notes would you not like to have my original manuscript. This contains a bibliography at the end of each chapter.

Sincerely,

Gilbert M. Smith

DEACIDIFIED

STANFORD UNIVERSITY

SCHOOL OF BIOLOGICAL SCIENCES

STANFORD UNIVERSITY, CALIFORNIA

June 14, 1946.

Dear Miss Esau:

By express I am sending you th e manuscript on the angiosperms. Now it is yours totreat as you see fit.

Sincerely,

Gilbert M. Smith

Organization of the Sporophyte. The sporophyte is composed of distinct parts or organs. The vegetative organs of the mature sporophyte are stem, leaves, and roots. Stem or root branches have, respectively, the same organization as the stem or the root, and are not regarded as distinct organs. Usually the stem is aerial and the root subterranean. This is not a universal condition, and instances can be pointed out where stems are subterranean or roots aerial. From the morphological standpoint a stem, whether aerial or subterranean, may be distinguished from a root by the manner in which the component cells are organized. Besides these morphological distinctions between the various organs of the plant, there are also certain physiological activities differentiating one organ from another.

Since longitudinal growth is always in the terminal portion, stems or roots are not the same age throughout their length, but progressively older backwards from the tip. It is possible, therefore, to distinguish four general zones or regions in the length of these organs. Beginning at the apex there is first the embryonic region in which cell division is taking place. Just back from this comes the region of elongation in which the cells are growing, especially in length. The line of demarcation between these two regions, as well as between the other regions, is not sharply defined but the two merge gradually one into the other. After the cells have attained their full size they next take on the characteristics of the various tissues of the organ, this phenomenon occurring in the region of maturation lying backward from the region of elongation. Farthest from the apex lies the mature region whose constituent cells have become fully differentiated.

From the periphery to the center, the mature region of the root or the stem is separable concentrically into three distinct zones, the two outer completely ensheathing the innermost. The outermost layer or epidermis is but one cell in thickness. The cortex that lies just within the epidermis is several cells thick and the cells may be of various types or all alike. Delimiting the cortex on its interior face lies the endodermis, a layer that is sharply distinguishable on morphological grounds in roots and in certain stems but not clearly discernable in other stems. The innermost region, the central cylinder or stele forms a solid column of cells. The outermost portion of the stele, the pericycle, may be one or more cells wide and these pericyclic cells may be either thin- or thick-walled. Within the pericycle lies the vascular tissue, the most conspicuous part of the stele. The vascular tissue may be a solid core, an annular zone, or individual longitudinal strands depending upon the organ or the plant concerned. It consists of two general types of cells the xylem and the phloem. These are differently arranged in regard to each other within the vascular tissue but the most common arrangement is phloem toward the outer and xylem toward the inner side. When the combined xylem and phloem do not form a solid core the central portion of the stele is a pith which can be differentiated from the other stellar tissues by its thinner walled cells and intercellular spaces.

The tissues thus far mentioned are primary tissues because they have all been developed by direct maturation of cells in the embryonic region. Between the primary xylem and phloem of many dicotyledons there is a band of cells, the cambium, that does not mature but divides to form new embryonic cells. The cells thus cut off towards the interior face of the cambium mature into xylem and those cut off towards the outer face mature into phloem. Xylem and phloem formed in this manner is termed <u>secondary</u> to distinguish it from the primary xylem and primary phloem formed directly from apical embryonic cells.

<u>Viewpoint of Morphology</u>. The study of the external and the internal organization of the sporophyte may be approached from a number of angles. From one standpoint the morphological discussion may consist of a cataloging of all of the various types of cells, their arrangement in the different plants, and the amount of each type of tissue that is developed. From another viewpoint, function is the main point of interest and all tissues must be interpreted in the light of the functions that they perform. Somewhat allied to this method of approach is that of stressing the development of the plants structural features in response to environmental factors, and an emphasising of the manner in which external influences stimulate or retard the formation of the various tissues and organs. The phylogenetic idea may dominate the consideration of the sporophyte and features of the plant that show the course of evolution are those that are considered of importance and placed in the foreground. All of the foregoing viewpoints are important and are not mutually exclusive one of the other. In considering the structure of the sporophyte one should bear in mind the phylogeny of the various tissues, their ontogeny, how external and internal influences affect their ontogenetic expression, and also the role that these tissues have in the different life processes.

CHAPTER II

The Apical Meristem. All the cells at the apex of the growing stem are in an embryonic condition. Cells of an embryonic region are capable of indefinitely repeated division, and, from the functional standpoint, this is their chief characteristic. Embryonic regions (Meristems) are found not only at the tips of stems and branches but also in roots and in the cambium of root and stem. Because of its position, the meristem at the growing tip of the stem is designated as an apical meristem. With the exception of a few genera , apical meristems are the only type found in monocotyledons. In dicotyledons the growth in length results from the activity of the apical meristem and the growth in thickness from the activity of the cambium, a type of meristem known as a lateral meristem.

Each cell of the apical meristem has a centrally located nucleus that occupies a considerable proportion of the space within the cell wall. The slimy cytoplasm occupies all of the space between the cell wall and the nucleus and contains numerous small vacuoles of varying shapes and sizes. The walls separating the component cells of an embryonic tissue are always very thin.

In the sense that growth means an increase in the volume of a tissue the amount of growth that takes place in an apical meristem is relatively small. In the sense that growth is an increase in the number of constituent cells, the region is one of great activity. The formation of new cells is always brought about by the division of one of the cells to form two daughter cells. The mechanism for this cell division is the spindle fibre system involved in the separation of the chromosomes during nuclear division. At about the time the daughter chromosomes reach the poles of the spindles, the fibres become more numerous, either by the formation of new ones or by the spreading apart of groups of fibres, and a swelling appears in the middle of each. Since the fibres are very close together these swellings come in lateral contact with one another to form a continuous cell plate across the equator of the spindle. The formation of new spindle fibres at the periphery of the spindle, and the appearance of swellings on them that fuse one with another, eventually extends the cell plate entirely across the cell. The cell plate is not a wall but is composed of living matter derived from the spindle fibres. After the cell plate extends across the cell, it splits into two parts that become the plasma membranes of the two daughter cells. There then follows the secretion of a cell wall between the two newly formed plasma membranes. The wall thus formed is made by both of, and is common to, the two daughter cells. The predominating chemical compound in this wall seems, according to the best evidence, to be calcium pectate. Afterwards there is the secretion of additional wall material on either side of this common wall by the plasma membranes. Thus the resultant wall between the daughter cells (primary wall), although very thin, does not have a homogeneous structure. When the partition between adjacent cells is thickened by secondary and by tertiary deposits the primary wall is also termed a middle lamella.

The orientation of the spindle of nuclear division in an embryonic cell, with reference to the longitudinal axis of the meristem, determines the plane of the wall separating the two daughter cells. In division of the superficial layer of cells the new walls are always formed perpendicular to the surface of the meristem. As a result this outermost layer always shows a regularity of arrangement. In some plants new cell walls in deeper seated cells are formed at all angles to, as well as perpendicular to, the surface of the meristem, consequently these meristem cells are polygonal in cross section and do not have a tendency towards regularity of arrangement. In other plants the great majority of the spindles are parallel to the long axis of the stem and, as a result, the walls formed between the daughter cells are perpendicular to the surface of the stem. In such cases the cells at the apex of the stem lie in vertical rows and the whole stem has a more or less definite cellular arrangement.

Tissues. In the course of the maturation of the embryonic cells of the meristem many different cell types are evolved. Cells of the same shape and structure are usually contiguous to one another and such a group of cells is termed a tissue. This is not the only usage of the term. It may also be used to designate all cells that have a common function or a common origin. Thus the vascular bundles or the cortex are spoken of as tissues although each is composed of several different types of cells each with a different structure and function. When the functional concept prevails less stress is laid on structural homogeneity. The term mechanical tissue, for example, stresses the function of certain cells of the stem and does not bring out the fact that these groups of cells may be different in structure, lie some distance from one another, and have a different origin. Although not capable of sharp definition the term is very useful in designating anatomical features of the stem.

Tissues of the Apical Meristem. As has been seen, the embryonic tissue of the apical meristem may have the component cells arranged in definite longitudinal rows. This regularity of arrangement is particularly striking in the stems of many hydrophytes, although there are instances where it can be demonstrated in mesophytes as well. Because of this definite organization the thesis has been advanced that the three