Laboratory Exercise: The Examination of Starch Grains

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EDITOR'S NOTE: This article gives instructions for a laboratory exercise which can be carried out by any serious student with a microscope in his school or at home. We hope to have further articles of this kind, and would welcome comments.

A beginning student of biology can carry out an interesting study of starch grains in plants with essentially no equipment other than a compound microscope, even one of limited range. Starch is the most abundant stored food material in the higher plants and, as such, is an important source of food for man. It occurs in the form of small granules or grains easily seen within the cells under a microscope. These grains are especially abundant, and hence easily seen, in plant tissues given over to storage such as tubers, fleshy roots, and endosperm of seeds.

There is a relatively specific staining test which aids in the recognition of starch and which is interesting to carry out even when starch is known to be present. If the material is treated with a solution of iodine and potassium iodide (available at any drug store) a blue coloration can be observed in the starch grains themselves. The staining solution may be prepared as follows: Dissolve one gram of potassium iodide in 100 cubic centimeters of water, preferably distilled. Add one gram of iodine crystals. This is a concentrated stock solution and should be diluted until the final solution has a straw-yellow color before using. Mount the material to be examined directly in the dilute solution.

Starch grains are formed in the cytoplasm of plant cells within specialized bodies known as plastids. These bodies are restricted to plant cells and are not found in animals except in some of the unicellular, flagellated organisms claimed by both botanist and zoologists. Plastids are of three types: chloroplasts, chromoplasts and leucoplasts. Chloroplasts contain chlorophyll and are the structures in which photosynthesis goes on. Chromoplasts contain other pigments and are responsible for certain other plant coloration, notably in flowers and fruits. Leucoplasts are whitish or colourless, since they contain no pigments; and they are the plastids that form starch grains. The grains are built up by the deposition of layer upon layer within the plastid. The plastid may become very much stretched by this process until it is merely a thin sheath around the grain; and it may even disappear entirely. If this happens, no further additions to the grain can be made. The deposition of starch in leucoplasts is often difficult to see. In leaves and stems above ground, however, the interior tissues often store starch in pale green chloroplasts; and in these the plastid can sometimes be seen because of its colour.

The form of starch grains differs from species to species; consequently it is worth while to examine starch grains in many different plants. It is even possible to identify a plant by its starch grains or to determine from what plant a given sample of starch has been prepared. This procedure is used by food inspectors to detect adulterants in commercial starch preparations. A little work of this type might make an interesting finale for the study of starch grains.

Potato Starch: Cut a potato and place some of the exudate from the cut surface or a thin scraping from the surface in a drop of dilute iodine solution on a glass slide. Cover the preparation with a cover slip.

The starch grains may become quite large, and the layered structure or lamination, can usually be seen quite clearly in grains of potato starch under the microscope. We can see the layers or laminae because they are of varying density and reflect light in differing degrees. They are excentrically constructed, that is their organic centre or hilum is not the geometric centre but lies considerably nearer to one end.

If you push carefully with a needle against the edge of the coverslip while you are observing, the grains will rotate. This indicates that they are not flat as they appear under the microscope.

Bean Starch: Soak a bean seed to soften the seed coat. Split the bean with a scalpel or sharp knife. Scrape off a small bit of cotyledon from the cut surface and place in a drop of iodine solution on a slide. Cover.

The grains appear oval or circular and slightly flattened. The lamination is very uniform. The hilum is centric. It appears hollowed, more circular in the rounded grains, and elongated in the oval forms. From this radial clefts extend which cut through the layers at right angles. They thin towards the periphery of the grain.

Wheat Starch: Prepare a slide using the endosperm material of Durum wheat (*Triticum durum*). The starch grains are large, circular and discoidly flattened. The hilum is central. Lamination is regular but difficult to see.

Oat Starch: The starch grains found in the endosperm of the oat (*Avena sativa*) are compound. The size of these grains varies as well as the number of grains in each compound grain. The individual grains appear polygonal, separated from each other by definite boundary lines. Numerous small angular grains will likely be seen which result from the breaking up of the compound grains. The hilum and the lamination will not likely be visible.

In the previous examples the starch grains were simple, i.e., only one was formed within a plastid. In other cases the deposition of starch begins in several or many centres within a single plastid. This results in the formation of a compound grain composed of a number of adhering grains.

Tradescantia Starch: If plants of *Tradescantia* (Wandering Jew) or *Zebrina* are available, make a thin cross section of the stem with a razor blade. Mount in water or the iodine solution. Observe the starch grains within the chloroplasts which look pale green around the starch.

Other suggested study materials: Pulp of green banana, barley kernel, rye kernel, corn starch, arrowroot.

Starch grains included in the chloroplasts of Tradescantia

Starch grains from a potato tuber showing the hilum and the lamination.

Large and small starch grains of Durum wheat (Triticum durum)

Starch grains from the cotyledons of Phaseolus vulgaris, the common bean.

A B

Oat starch from Avena sativa. A, a compound grain; B, its component grains.