Preparation and Use of Collodion Tubes

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Most of the information in the first course in general botany at Oregon State College is oriented around the fundamental biological concepts of nutrition, growth, and reproduction, and it is believed that an early understanding of the phenomenon of diffusion is necessary for the concept of nutrition, which is presented at the beginning of the course. Our experience has shown that collodion tubes are a satisfactory tool for this purpose. They are easy to make and give the desired effect without the use of elaborate and expensive equipment.

The usual method employed in making collodion tubes is to pour collodion solution into a test tube and revolve until a thin layer has been deposited on the inner surface. When the collodion becomes dry, the top is loosened and the tube withdrawn. This process is slow and tedious, especially when large supplies of tubes are needed.

We have designed an apparatus which will speed up and simplify the making of a larger number of tubes (Fig. 1). The set-up consists essentially of a wooden rack, a metal tube, and a source of air pressure, such as a motor driven air pump or pressure tank.

The frame of the rack is made from 2⅜ × ⅞ in. lumber, and consists of two uprights joined to a horizontal base. The base piece may be heavier and thicker. The horizontal length of the rack will depend on the number of test tubes used and the amount of air pressure available. The over-all height is 11 in.

Two upper horizontal crosspieces are provided with holes. The top crosspiece contains six or more bored holes, evenly spaced and large enough to

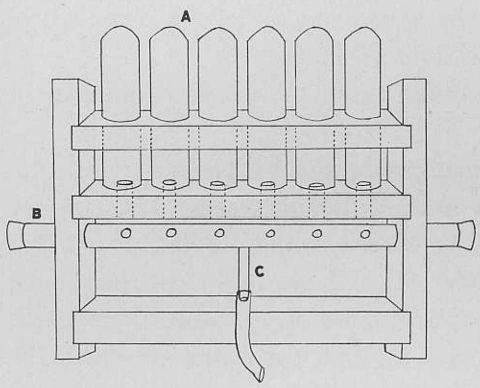

Fig. 1.—Design of rack for making collodion tubes.
A, *test tubes;*
B, *brass tubing turned at angle to show air vents;*
C, *inlet for air.*

admit freely proper size test tubes (a diameter of 1 in. and length of 5 in. is a convenient size test tube) (Fig. 1,*A*). The lower crosspiece is 2 in. below the upper crosspiece and is provided with a similar number of holes about half the diameter of those in the top and centered with them.

The air tube is either of metal or glass (¾–1 in. in diameter) and is suspended horizontally under and against the lower crosspiece (Fig. 1,*B*). It is also provided with air release holes (⅛ in. in diameter) which are centered with the holes in both crosspieces. An intake stem connection is provided for air flow (Fig. 1,*C*). Both ends of the tube are sealed with rubber stoppers.

Collodion can be purchased ready for use or it can be made by dissolving air dried celloidin in the proportions of 10 grams of celloidin to 200 ml. of equal parts of absolute alcohol and anhydrous ether. Occasional stirring is necessary. After one or more days, the mixture should be ready and have the consistency of maple syrup.

The solution of collodion is poured into a test tube and the tube slowly rolled by hand until the inner surface is covered with a thin layer. The excess is poured out and the tube inverted through the upper hole in the rack coming to rest over the lower hole. The air supply is started and by the time the last tube is inverted, the first tube is dry and the collodion membrane has loosened or can be loosened from the walls of the test tube. Water is then allowed to run between the test tube walls and dry collodion, after which it can be easily removed. The longer the drying the more impermeable the collodion tube becomes. Alcohol in the collodion solution evaporates at a slower rate than ether. If not thoroughly evaporated there will be weak spots in the tube. Collodion tubes can be stored indefinitely in a sealed jar of water to which has been added a thin layer of Toluol.

By this method as many as fifty or more tubes can be made in two or three hours and stored for future use.

It usually requires two persons to manipulate the filling and tying procedure when making a demonstration using collodion tubes. This can be reduced to a one-man operation by using a rack similar to the above, but without the lower crosspiece and air tube (Fig. 2,*A*). A ¼ in. thick cross section disc is cut from the large end of a No. 10 or 11 rubber stopper. It is provided with a hole ¾ in. in diameter through the center to which fits a smaller tapered rubber stopper. This smaller stopper is provided with two holes and has a filter tube or small funnel through one hole, and a short piece of glass tubing through the other for an air escape. The larger disc is centered and either tacked or glued securely over the hole in the rack. The tapered end of the smaller stopper is inserted through the open end of a collodion tube when ready to fill so that the tube edge is from ½ to ¾ in. over the end of the stopper. The tube is inserted through the opening in the larger rubber disc and the smaller stopper wedges it securely against the rounded edge of the disc. Then the tube may be filled through the filter tube, tied

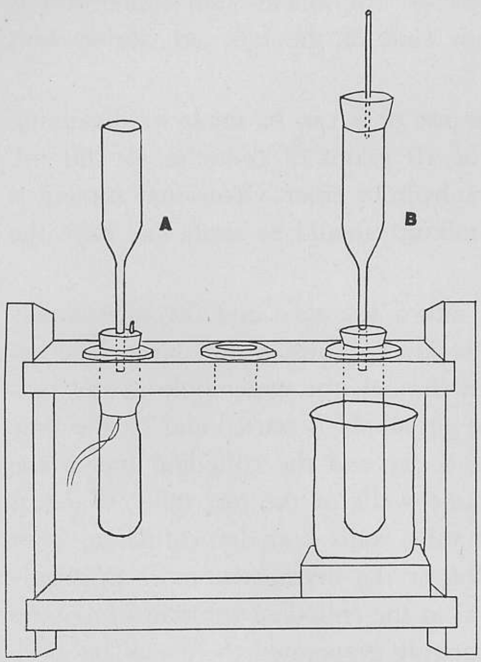

Fig. 2.—Design of rack used for: A, *filling and tying collodion tubes;* B, *measuring inward diffusion of water by its rise in a capillary tube.*

from below, and the smaller stopper released. Two or more sets can be provided on each rack.

Collodion tubes function satisfactorily as differentially permeable membranes with sugar and some salts in water solutions. They are, for practical purposes, impermeable to them as well as to suspensions of insoluble and soluble starches. Water diffuses readily through the collodion membrane. The tube can, therefore, be used to illustrate osmosis and osmotic pressures.

The same rack can also be utilized to measure the inward diffusion of water by its rise in a capillary tube (Fig. 2,*B*). The procedure for filling the tube is the same as described above, except that the upper opening of the filter tube is fitted with a one-hole stopper through which is inserted a 3-ft. capillary tube supported upright by a clamp and ring stand. Both the collodion tube and filter tube are filled with a 34 per cent sucrose solution to which has been added a dye such as saffranin O. Hand pressure applied to the collodion tube will dispel any air space in the tube and insure a continuous column of solution. The stopper, with its capillary tube, is secured to the top opening of the filter tube. The collodion tube must be wedged securely through the hole in the disc. Danger of leakage can be prevented if the tube is brought well over the end of the small rubber stopper and tied securely with several turns of bees-waxed or resined string before inserting in the disc. The filled collodion tube is immersed in a beaker of water. Water will readily diffuse through the membrane to its lesser concentration and result in an osmotic pressure. A rise of 2 cm. or more per minute in the capillary tube is possible and the column will eventually rise up and over a 3-ft. length of capillary tube. The rate of diffusion for different solutions can be shown by changing beakers and solutions.