Similar samples were then prepared from solutions of 0.01% actomyosin in 0.5 molar KCl to which ATP had been added in sufficient quantity to make its final concentration 0.01%. Fig. 1b is a picture of such an ATP-treated specimen. As can be seen in the figure, the bulk of the elongated fibrils of actomyosin have been changed into shortened, thickened irregularly shaped forms. They are of different sizes, as is to be expected from the wide distribution of particle size in the untreated specimen.

It was impossible to study the effect of varying KCl concentrations on actomyosin in the electron microscope. The changes in salt concentration which occur in the preparation of the sample make it impossible to know with any accuracy the effective KCl concentration.

Thus, we have obtained evidence from light-scattering observations which indicates that actomyosin dispersed in KCl solution has the configuration of a slightly coiled particle. Increasing the concentration of KCl does not affect this configuration. On the other hand, as shown by light-scattering data reinforced by electron micrographs, ATP increases the degree of coiling of actomyosin, an effect which is compatible with a fundamental role in muscular contraction for this nucleotide-protein interaction. Further studies on both the ATP and KCl effects are in progress.

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IN THE LABORATORY

Modification of the Kardos Shadow Experiment for Demonstrations of Color Mixing

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In an experiment first described by Kardos (*2*), a small disc is suspended in the center of a hole in a screen. The screen is illuminated from a strong source, but an object is interposed to cast a shadow on the disc, so that the edges of the shadow fall within the hole around the disc. With this arrangement, and using a light gray screen and disc, the latter appears to be black, or very dark gray, even though the observer can see the source of illumination and the shadow caster and, seated slightly to one side, can observe that the shape of the shadow falling on the wall to the rear of the screen is not of the same shape as the disc. The illusion is so compelling that even continued observations, alternately of the normal disc color without the shadow and of the disc in the shadow, do not serve in any way to decrease its strength. Descriptions of this and similar experiments may also be found in Brunswik (*1*) and Woodworth (*3*).

A different, but equally striking effect, can be produced by having the room in semidarkness and illuminating the disc alone with a brilliant source. In this case the disc appears to be a source of light itself, much as the moon seems to be. It was while investigating the effects of colored light on such a disc that the writer found the Kardos apparatus to be a most excellent device for demonstrating color mixing.

The screen used was of light gray cardboard, 35″ long and 23″ high. From the center a circular hole 8″ in diameter was cut. Within this hole a 4″ disc was suspended by means of thin black threads, crossed to suspend the disc steadily and fastened to the rear of disc and screen with cellulose tape. (In the Kardos experiment, the disc is of the same material as the screen, but for color mixing a white disc may be used if desired.) For illumination, two or more strong, narrow beams of light and suitable colored filters were used. With the screen about 4′ from the rear wall and the observers seated slightly to one side so that they can see where the edges of each light beam strike the wall, it is possible to examine the results of the mixture on the disc while being able to see an "analysis" of the colors used on the rear wall.

With this apparatus and good red and green filters, it is possible to produce a powerful, well-saturated yellow on the disc, quite unlike the dirty yellow usually achieved with a color wheel or the weak, streaky effect usually obtained with lights observed through milk glass. With blue and yellow filters or three sources—red, green, and blue, a bright white is easily achieved. Relative brightnesses can be regulated by polaroid filters, episcotisters, or distance of source, whichever may be convenient.

In addition to color mixing, a great variety of demonstrations of afterimages, simultaneous contrast, and induction of the complementary color in contrast shadows may be performed with this apparatus. For example,

the screen may be flooded with one color, with a shadow caster between the disc and this source, while a different color is used to illuminate the disc alone.

The advantages of this device over others previously tried by the writer are numerous. First of all, the students can see everything that is done; there are no concealed light sources, no elaborate equipment. An equally important feature is the fact that the colors seem to be in the object viewed and not merely cast upon the wall or diffused from behind through milk glass. There are no fringes of monochromatic light, which often serve to reduce the vividness of the mixture. It is true that such fringes may be removed by observation through a reduction screen, but such a procedure always tends to destroy the appearance of surface color to a considerable degree. A further advantage is the speed with which variations in the demonstrations may be set up; one of the most annoying things about color wheels is their inefficiency in this regard. Should it be desired to move the apparatus from room to room, the screen could easily be given a wooden frame so that it could be moved about and set on classroom desks. Portability of the light sources would depend upon the type available. Finally, this apparatus affords a negligible storage problem when not in use.

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Recent Procedures for the Study of Three-dimensional Shapes of Resting Cells, and a New Method for the Shape Study of Cells in Division

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Since detailed studies of three-dimensional shapes of cells in tissues are relatively recent, standardized techniques have not as yet been adopted. The first investigations (*2*) utilized essentially Born's wax plate method. In this, individual cells were reconstructed from serial sections and examined under the compound microscope, the sections being modeled consecutively in sheets of wax. Subsequently a wax impregnation technique was employed (*5*), in which masses of cells were infiltrated with a hard wax. The wax casts of individual cells were then separated, studied under a binocular dissecting microscope, and modeled face by face.

In later work cells were analyzed in tissues, without sectioning or separation. In some cases the tissues were killed, stained either with safranin or Delafield's hematoxylin, cleared in xylol, and mounted in mineral oil. They were then studied under the binocular dissecting microscope. In another instance (*1*) living cells were stained lightly with neutral red, mounted in water, and studied similarly. All of these investigations have dealt with relatively large and mature cells.

Although the binocular dissecting microscope is well adapted to three-dimensional cell shape studies, the possibility of using it is eliminated in some of the most fundamental parts of the plant, such as the apical meristems, because of insufficient magnification. In the study of the three-dimensional shapes of minute cells, two different techniques have been used. In the first, the Duchartre-Lewis method (*3, 4*), longitudinal and transverse sections of the tissues were made; from these the number of faces, in section, could be determined under the compound microscope and the average number of faces per cell computed. While this method is helpful in determining the average number of faces, it has obvious limitations: it works best in tissues with the cells regularly arranged, it does not tell the precise number of faces on any individual cell, and it gives no information on the kinds of faces (whether they are quadrilateral, pentagonal, etc.). In the other investigation of minute cells (*6*), dealing with the apical meristem, stem tips were cleared in lactic acid (*8*), stained in Delafield's hematoxylin, and mounted "in toto" in balsam. They were then studied under the compound microscope.

Finally, in investigations now under way, the three-dimensional shapes of dividing cells in telophase have been analyzed. More specifically, the problem to be solved was determination of the original shape of the individual cells before division and of the two daughter cells directly after division, in order to make comparisons of the shape changes involved in the process of mitosis. To accomplish this it was necessary to see clearly the nuclei, both resting and dividing, the spindle fibers and cell plate, and the original walls of the cells. However, since the walls of several superimposed layers of cells had to be identifiable, merely by focusing, they could be stained only lightly. Furthermore, the dense cytoplasmic contents of the meristematic cells had to be nearly or quite transparent so that the components to be studied would not be obscured. To achieve the desired results the preparations were stained with Feulgen, ruthenium red, and orange G. The procedure was as follows:

Stem tips of *Anacharis densa* (Elodea) were dissected out, killed in Craf fixative, embedded, and sectioned at 25 μ or thicker. They were then stained with the Feulgen technique as outlined by de Tomasi (*9*), except that they were hydrolyzed longer (30 min) in N HCl and stained in decolorized fuchsin for 24 hrs. After being rinsed in distilled water the slides were put into a strong aqueous ruthenium red solution for 30 min, quickly rinsed again in distilled water, and run as rapidly as possible into absolute alcohol. They were then stained for about 1½ min in orange G in absolute alcohol and clove oil, rinsed in clove oil, put into xylol, and mounted in neutral balsam.

By this procedure the chromatic figures of the dividing nuclei were stained deep purple, while the color of the resting nuclei was much less intense. The middle lamella was darkened with ruthenium red, while the spindle fibers and cell plate were stained, to some extent with orange G.