which I have just described. Evidently the celebration of the fiftieth anniversary of the dynamo should have been held about two years ago.

H. W. WILEY

SCIENTIFIC BOOKS

Biochemical Laboratory Methods for Students of the Biological Sciences. By CLARENCE AUSTIN MORROW, PH.D., John Wiley and Sons, New York, 1927.

THIS book by the late Clarence Austin Morrow, until his death in 1926 professor of biochemistry at the University of Minnesota, is a volume which will be welcomed by all teachers and students in biochemistry, botany, general physiology, pathology, agronomy and bacteriology. It was written by a man who had had extensive teaching experience in biochemical laboratory methods. Each of the experiments given in the book, and there are two hundred and thirty-three, has been thoroughly tested out in the student laboratory by college classes.

The general field of physical and chemical biology is greatly in need of texts. This volume by Dr. Morrow fulfills one of these needs. As one reads the interesting experiments outlined, one wishes again and again that the author had wandered astray to discuss the theory of the behavior of nitrogen-containing compounds. It is hoped, therefore, that this laboratory manual of biochemistry will soon have a companion volume, by some equally capable teacher and writer, dealing with the theory of biochemical behavior.

Too often in laboratory manuals are the time-honored and time-worn methods given so that the student comes to think that this is the only way and these the only materials, but in Dr. Morrow's book this is not the case. The experiments are well chosen and depart in the main from stereotyped forms.

The first chapter is on the "Colloidal State" and covers the subject briefly but well. The only adverse criticism which I can make of Dr. Morrow's book has to do with subject-matter handled in this first chapter. The faults are not serious, and I call attention to them more because they happen to touch upon two subjects in which I, for some time, have had a personal interest. Morrow helps to perpetuate the now antiquated term "emulsoid." This expression has become so firmly established in physical and chemical biology that it seems difficult to eradicate it even though it has long since been discarded by most chemists and never was accepted by such colloidists as Zsigmondy and Donnan. There is not sufficient reason to believe, nor do many workers in the field now believe, that hydrophilic colloids of the gelatin type are fine emulsions. We can, however, partially forgive Dr. Morrow for continuing the use of this expression, a relic from the early days of colloidal chemistry, since he has done the very correct thing of putting the emulsions in a class by themselves, where they, as liquid suspensions, belong.

The second adverse criticism has to do with the support which is given to the attempt of others to draw a distinction between viscous and plastic flow; but here Dr. Morrow has numerous capable investigators on his side. The conception that plastic flow is fundamentally different from viscous flow is a sound one and is based on the fact that viscous substances flow no matter how low the rate of shear, provided the shearing force acts over a sufficient interval of time, while plastic substances do not flow until a certain definite shearing force has been exceeded. Plasticity is made up of two fundamental properties, yield value and mobility. The former is dependent upon the shearing stress required to start deformation, while the latter is proportional to the rate of deformation after the yield value has been exceeded. These properties and the distinction they emphasize between viscous and plastic flow are generally recognized and hold for such a substance as lead which does not exhibit viscous flow until a maximum stress is applied. The fact that lead will flow, as when forced through small holes under pressure, does not interfere with our conception of lead as a solid; but with colloidal jellies the case is different.

To call a thin solution of gelatin or soap a solid, because it possesses such solid properties as elasticity and rigidity, even though its viscosity may be but twice that of water, is as misleading and as meaningless as it would be to call metallic lead a liquid. The distinction between liquid and solid becomes purely arbitrary when applied to colloidal substances of the gelatin type.

But a more serious objection to the point of view that elastic colloidal solutions exhibit plastic flow is that plasticity already has a definite meaning in physics and refers to that property which permits a substance to be deformed and yet show no tendency to return to the original shape. This is not true of elastic colloidal substances such as gelatin, rubber, protoplasm or any jelly.

The whole difficulty in this matter seems to me to lie in the failure to realize that in solutions of gelatin and the like we are dealing with two properties, viscosity and elasticity, and the type of flow is determined by the presence of these two properties. Gelatin is not plastic. No elastic substance can be

if we stand by our old and recognized definitions. Gelatin does not at first show true viscous flow because of the interference of elasticity, or, if we get back to the cause of elasticity in jellies, because of the presence of a structural framework. When this structure is broken down, *i.e.,* when the elastic property is completely overcome, as is true at maximum stress, then true viscous flow results. This is seen in determinations by Freundlich of viscosity coefficients of elastic solutions by the capillary (Hess viscometer) method. The measured viscosity value rapidly falls with increase in pressure until a maximum stress (of 60 mm. Hg) is reached when the curve becomes a straight line. At this point of maximum pressure elasticity no longer interferes with capillary flow. The structure of the liquid elastic jelly is broken down and true viscous flow, with constant viscosity values, results. This, then, is the explanation of the deviation from Poiseuille's formula of elastic colloidal solutions.

The preceding criticisms are directed not against Morrow's excellent volume but against two viewpoints which, in the first case, has long persisted in biology, and, in the second case, is a new conception for which there does not appear to be sufficient justification.

The second chapter of Biochemical Laboratory Methods has to do with the Physical Chemical Constants of Plant Saps. Here Morrow gives methods for determining osmotic pressure, molecular weight, water binding power, and electric conductivity, using in every case plant sap as experimental material, thus pointing out that what sometimes appears to be a course in physical-chemistry is really the application of physical-chemical methods to biology.

Chapter three, on H-ion Concentration, illustrates again the excellent method of presentation followed in the book. In this chapter Morrow has given the biological student all he needs to know of H-ion concentration in order to do good work and to understand the subject without losing himself in a maze of theory and mathematics.

Chapter four is on the Proteins, their tests, and their preparation. It is this phase of the subject with which Dr. Morrow was especially well acquainted, and it is also that field of experimental endeavor which has made the Division of Agricultural Biochemistry of the University of Minnesota so well known. The chapter, therefore, becomes a valuable contribution to our knowledge of the isolation of natural plant proteins. Some of the experiments have to do with animal material, as cystine from hair, tryptophane from casein, etc.

Perhaps the most encouraging thing which the teacher of biochemistry will find in the fourth chapter of this book is the realization that it is possible to prepare in the student laboratory reasonably pure plant proteins. The preparations are not easy, but they can be done by the student and have, in addition, the pedagogical value of teaching the student that pure proteins are things to be worked with under carefully controlled conditions. By the time the student has isolated globulin from the peanut, or gliadin from wheat flour, or prepared some of the amino acids such as tryptophane from casein, as described by Morrow, he will have a wholesome respect for the value of his preparations, and yet have the satisfaction of knowing that he can do the work and do it well. The classical work of eminent investigators on plant proteins is likely to discourage not only the student but the teacher from attempting to duplicate even the simplest of these experiments in class laboratories. When confronted with such difficulties it has always been my policy to go ahead and do the best that I can. If the answer to the question of whether or not an experiment is to be attempted is to rest on the degree of precision or purity of the results, then many a biological problem will remain untouched. Who, after all, knows what a pure protein is? The same difficulty confronts every worker on living matter. One of the most impressive features of Morrow's book is the realization that precise physical-chemical methods are brought to bear on biological problems and that biology is gradually becoming an exact science, an encouraging thing when one realizes the many almost insurmountable difficulties involved in experimental work on living matter.

I recall with amusement the irritable attitude of a physicist who objected to my crude method of determining the viscosity of protoplasm. He said it would be so simple a matter to make precise observations by merely running the protoplasm through a capillary viscometer! I remember, too, the similar state of mind of a chemist who was annoyed at my speculating on the structure of protoplasm when he did not yet know the structure of such relatively simple non-living substances as gelatin. It is a joy, therefore, as one reads Morrow's book to appreciate the extent to which chemistry has brought accuracy into biology, just as physics brought accuracy into chemistry, and as mathematics has brought accuracy to all.

Chapter five deals with the Carbohydrates. Methods of extraction and identification of the saccharides are given. A considerable variety of plant material is selected as a source for extracting sugars.

Chapter six on the Glucosides, and seven on the Fats. Animal material is again resorted to, as a source for cholesterol and lecithin.

Chapter eight has to do with Enzymes and chapter nine with Plant Pigments.

These last chapters of the book are much more complete than this brief review indicates, for they represent, as I have said, that field of biochemistry to which Morrow devoted his life. The value of these chapters is greatly added to by the giving of methods which have not before appeared in print, methods developed not only by Morrow himself but by his colleagues.

Dr. Morrow's book on biochemical laboratory methods is one which should be in the hands of every teacher and student in biochemistry, biophysics and physiology.

WILLIAM SEIFRIZ

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A COMBINED FIXATIVE AND STAIN FOR DEMONSTRATING FLAGELLA AND CILIA IN TEMPORARY MOUNTS

BELOW is given a new fixative-stain combination, which has proved to be especially suitable for the rapid preparation of temporary mounts to show flagella and cilia. The reagent contains:

80 cc	saturated solution of phenol in water
20 cc	40 per cent. solution of formaldehyde in water
4 cc	glycerine
20 mgms	gentian violet

It is advisable, in order to facilitate the dissolving of the dye, to moisten it thoroughly with a cubic centimeter of water before adding the other ingredients.

Mix a drop of the reagent with a drop of the culture or infusion containing the organisms to be studied. The flagella and cilia stain clearly, while the cell body remains quite natural in shape and sufficiently transparent to observe the nucleus and the other cytoplasmic structures, such as granules, pharyngeal rods, chloroplasts, pyrenoids, paramylum bodies and the like. The background remains practically colorless, the dye concentrating itself in the organisms. The depth of the stain can be regulated by varying the proportions of reagent to infusion.

The reagent promises to be extremely useful in demonstrating flagella to elementary classes and in identifying the minute flagellates in protozoology courses. It has been used with surprising success on Oicomonas, Tetramitus, Menoidium, Peranema, Euglena, Astasia, Chilomonas, Polytoma, Naegleria and others. It will undoubtedly prove useful as a quick method for studying the flagellated stages of algae, fungi and myxomycetes.

The cilia, cirri, membranelles and undulating membranes of the ciliates are stained by it in approximately natural form, permitting an accurate determination of the number of the ciliary rows, and the arrangement and number of the cirri, membranelles and membranes. To any one who has tried to work out the exact arrangement of the locomotor organelles of a small hypotrich the advantage of such a reagent is obvious.

For staining internal protozoan parasites it is advisable to use more glycerine and dye (approximately 8 cc glycerine and 25 mgms gentian violet have given good results). The presence of mucus interferes with the staining process. It is consequently advisable to mix the material to be examined with three or four times its volume of normal salt solution before using the reagent. With these precautions the method has been used with success on Trichomonas, Chilomastix and Balantidium. With further work along this line it might be possible to develop a method that would materially facilitate the diagnosis of intestinal and other parastic protozoa.

Unfortunately the reagent does not work well with Paramecium, since the discharge of the trichocysts tends to tear away the cilia, but satisfactory preparations have in some cases been obtained in spite of this difficulty. With smaller ciliates, such as Cyclidium, Colpidium, Urotricha, Colpoda and Aspidisca, the method works beautifully; and in larger forms without a heavy trichocyst layer very satisfactory results have been obtained, for example with Stylonchia, Ophryoglena and Chilodon. The cilia stand out as clear blue, individual threads.

Bacteria stain clearly and stand out distinctly against the colorless background. It is possible in the filamentous types to observe the gelatinous sheath in which the rods are imbedded. However, the flagella of the motile forms, such as the larger spirilla and bacilli commonly found in laboratory infusions, do not take the stain.

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