of the anion concentration by means of concentration cells. A further increase in the amount of acid will now serve to decrease the concentration of protein ions by increasing the concentration of the common anion. The concentration of ionized protein will therefore pass through a maximum which should coincide with the maximum for the rate of digestion. If the ordinary theory of chemical kinetics, on the basis of the law of mass action, be applied to the above system, it may be predicted that:

I. The optimum hydrogen ion concentration for the digestion of the protein must coincide with the hydrogen ion concentration at which the concentration of protein ions and therefore the conductivity due to the protein is at a maximum.

II. The limiting pH for the activity of pepsin on the alkaline side must depend on the isoelectric point of the protein, since this is the point at which the protein first begins to react with the acid.

III. The addition of a salt with the same anion as the acid to a solution already containing the optimum amount of acid will have the same depressing effect on the digestion as the addition of the same amount of anion in the form of acid.

IV. The pepsin should combine with the protein only when the latter is ionized, *i.e.*, pepsin should behave the same as the inorganic anions studied by Loeb.

These predictions have been tested quantitatively and found to be fulfilled. It has also been found by direct experiment that neither the influence of the acidity on the destruction of the enzyme, nor the viscosity of the protein solution can account for the influence of the hydrogen ion concentration on the rate of digestion.

It will be seen that from this point of view pepsin digestion is a chemical reaction in which the pepsin as well as the protein takes part. It is therefore not a catalytic reaction at all in the classical sense. The specificity of the reaction is therefore probably governed by the same conditions that determine the specificity of any chemical reaction, since from a quantitative standpoint each chemical reaction is specific. It may be added that a very similar mechanism was proposed by Stieglitz and his collaborators for the hydrolysis of the imido esters by acid.

It is, of course, impossible at present to apply these results directly to the activities of the living organism since conditions there are much more complex. It is probable, however, that much of the apparent complexity is due to the fact that several processes, each simple in itself, occur simultaneously and thus lead to a complicated result. Dernby's[5] experiments render it probable that the phenomenon of autolysis may be explained in this way.

John H. Northrop
Rockefeller Institute for
Medical Research

KNIPP'S SINGING TUBE

My colleague, Dr. C. T. Knipp, when constructing a piece of apparatus, found that one of the parts—a glass tube intended for a mercury trap—gave forth a musical sound under the heating action of a gas flame. Following this clue he constructed various modifications of the tube and described them with the interesting results obtained.[1] Inquiry has been expressed concerning the explanation of its action. It occurred to the writer that this explanation might be found in the theory advanced for similar cases where sounds are maintained by heat.[2]

Fig. 1 pictures one type of the tubes tested. It is a resonator with a loop at A and a node at N, so that the distance $ABCN$ constitutes approximately one fourth of the wave-length of the sound given out by the tube when operating.[3] The air surges back and forth at A with the greatest velocity and displacement. From this point the to and fro motion of the

[5] Dernby, K. G., *Biochem. Z.*, 1917, LXXXI., 198.

[1] *Phys. Rev.*, Vol. 15, p. 155, 1920; and other publications.

[2] Rayleigh, "Theory of Sound," Sec. 322. Barton, "Text-Book of Sound," Sec. 265–277.

[3] *Phys. Rev.*, Vol. 15, p. 336, 1920.

air grows gradually less until it becomes zero at the node N. Compressions and rarefactions have maximum values at N and grow less in intensity until at A there is no change in pressure. The oscillating motion will persist for a number of vibrations until the friction with the sides of the tube gradually brings about a condition of rest. If the motion is to be maintained, energy must be supplied to the vibrating system. In Dr. Knipp's apparatus, this energy is furnished at cc by a ring burner gas flame.

As the air surges up the tube and turns to pass into D, it is brought into intimate contact with hot glass at CC. This portion of heated air communicates its energy to surrounding air particles at D and results in a general rise of temperature in this region. It tends to expand the air. Just at this time, the air begins to surge in the opposite direction throughout the tube and the tendency to expand at D assists this return surge.

When the air surges back from D to EE it becomes heated again at C and the heat acquired is given up partly to the glass at EE, thus causing a cooling and consequently contraction. In the meantime, the air has finished its outward motion and is ready to

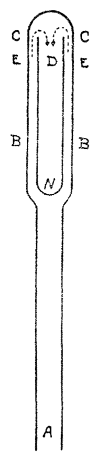

FIG. 1.

surge back toward the inner part of the tube. The cooled air at EE by its contraction assists this motion. Thus, the motion is maintained first by the heating effect (expansion) at D and half a period later by the cooling effect (contraction) at EE.

The alternating motions are quite rapid since the vibrations in the various types of tubes range from 30 to 250 times per second. It is well established that air may be heated and cooled thus rapidly because the accepted explanation for the propagation of sound in air requires this rapid change in temperature.

The amplitude of the motion at CC is not great but appears to have a range from 0.5 to 1.5 cm., depending on the tube used. The lower pitched tubes have the larger amplitude. The area of glass heated is small so that the temperature gradient from the red hot glass to the cooler portion 0.5 cm. distant may be several hundred degrees, thus allowing a confirmation of the theory advanced.

The additions and subtractions of heat to the air are not impulsive but, by the processes of transmission explained, gradually build up to maxima at suitable instants to maintain the motion. Cooling the tube at BE assists the vibration. The motion is maintained more easily if the area of the annual ring at BEC is made smaller than the area of the tube at D. This results in a greater amplitude of motion at C in agreement with the theory.

Mechanically, the motion may be likened to the motion of a system consisting of a spring that is fastened at one end with a weight at the other end that vibrates back and forth. (See Fig. 2.) When the mass m moves to the

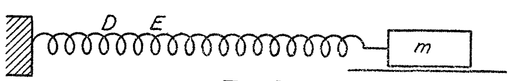

FIG. 2.

left, the spring is compressed and presently when equilibrium is reached, the motion reverses. If, at this instant, the spring at D could be strengthened by the insertion of several coils, the return motion would be assisted. This corresponds to the addition of heat in Dr. Knipp's tube.

When the spring has expanded to the other limit of its vibration, imagine several loops of the spring at *EE* removed so that the tension, or pulling together of the spring, is strengthened. There is a consequent additional pull on the mass just when it is needed to encourage the motion. This effect corresponds to the cooling of the air in the singing tube at *EE*.

F. R. WATSON

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS

THE AMERICAN PHYSIOLOGICAL SOCIETY

THE American Physiological Society held a very successful meeting at the University of Chicago during convocation week. The scientific program covered three days of December 28, 29 and 30 with two daily sessions each. The evenings were given to general meetings and social intercourse. On the evening of December 28 the Physiologists joined with the other Biological Societies in the annual dinner of the Federation of American Societies for Experimental Biology.

The dinner is looked forward to by the membership as the annual social event of the meetings. Dr. Roswell H. Park, president of the American Society for Experimental Pathology and chairman of the executive committee for the year 1920 presided at the dinner. Addresses were made by Dr. Simon Flexner, of the Rockefeller Institute for Experimental Biology and Medicine, and Dr. William H. Howell, of the School of Hygiene and Public Health of the Johns Hopkins University. A less formal dinner was also held on the evening of December 29.

The chief events of the two business meetings of the Physiological Society were the following:

1. Announcement of the forthcoming introductory number of the new journal issued under the auspices of the society, *Physiological Reviews*, which appeared early in the new year.

2. The annual dues for 1921 were fixed at $2 by the council.

3. The council announced the appointment of Donald R. Hooker as managing editor for the *American Journal of Physiology* for 1921.

4. The council announced the appointment of Donald R. Hooker as managing editor, and Wm. H. Howell, J. J. R. Macleod, Frederic S. Lee, D. R. Hooker, L. B. Mendel, Reid Hunt and Gideon H. Wells as the editorial board for *Physiological Reviews* for the year 1921.

5. Reports of the treasurer were received and audited.

6. The officers elected for the ensuing year are:

President, J. J. R. Macleod, University of Toronto.
Secretary, Chas. W. Greene, University of Missouri.
Treasurer, Joseph Erlanger, Washington University, St. Louis.
Councilman for the term, 1921–1924, A. J. Carlson, University of Chicago.
Councilman for the unexpired term of President-elect Macleod, J. A. E. Eyster, University of Wisconsin.

7. The following new members were nominated by the council and elected by the society:

J. B. Collip, A.M., Ph.D., assistant professor in physiology and biochemistry, University of Alberta.
W. Dennis, A.M., Ph.D., assistant professor of physiological chemistry, Tulane University.
L. R. Dragstedt, Ph.D., assistant professor of physiology, University of Chicago.
F. S. Hammett, A.B., M.S., Ph.D., fellow in biochemistry at the Wistar Institute.
Fraser Harris, M.D., D.Sc., professor of physiology and histology, Dalhousie University, Halifax, N. S.
Selig Hecht, Ph.D., assistant professor of physiology, Creighton Medical College, Omaha.
Davenport Hooker, B.A., M.A., Ph.D., professor of anatomy, University of Pittsburgh, School of Medicine.
Norman M. Keith, instructor in medicine, Mayo Clinic, Rochester, Minn.
S. O. Mast, B.S., Ph.D., professor of zoology, Johns Hopkins University.
Jas. M. D. Olmsted, M.A., Ph.D., assistant professor in physiology, Toronto University.
Thos. L. Patterson, A.B., A.M., M.S., Ph.D., assistant professor of physiology, University of Iowa.
Maurice I. Smith, B.S., M.D., pharmacologist, U. S. Public Health Service, Washington, D. C.

8. A new fellowship for Research in Physiology was established under the control of the society by the generous contribution of William T. Porter, of the Harvard Medical School. Dr. Porter contributed $1,200 as an annual stipend to establish a fellowship for research in physiology under the auspices of the American Physiological Society and the administration of its council. The acceptance of the proposition was recommended by the council and accepted with appreciation by vote of the society. The fellowship will begin October 1, 1921, and is to be filled by nomination by members of