tion (2)[3] is 0.8 for mice and 0.04 for cows.) This means that the *physiological* significance of a *physical* unit of time is about 20 times as great in the mouse as in the cow. *Physical* mass and time thus have different *physiological* significance in different species, individuals, and ages. Physical units of time are therefore ambiguous when applied to biological processes. There is need for clarification of *physiologic* units of mass and time. In the same category is the need for determining physiological equivalence of time and mass in different species of animals, so as to enable the transfer of experimental results from one species, individual, or age, to other species, individuals, or ages.

SUMMARY

It appears that while the immediate objectives of the agriculturist differ from those of the academic biologist, the long-range needs for standards of growth and aging, for physiologically equivalent units of time and mass, and for knowledge of the influence and mechanisms of various internal and external factors on growth and related processes are the same for both. This suggests that these two groups of biologists should work together more closely.

# Technical Papers

## Cardiac Failure in Cattle on Vitamin E-free Rations as Revealed by Electrocardiograms[1]

THOR W. GULLICKSON and CHAS. E. CALVERLEY[2]
*Minnesota Agricultural Experiment Station*
*St. Paul*

During the past 8 or 10 years, in connection with an extensive study designed to determine the role of vitamin E in the nutrition and reproduction of cattle, a considerable number of the animals fed vitamin E-free rations throughout their entire lives have died suddenly and without evident cause as revealed by gross post-mortem examinations. The deaths have occurred among animals of both sexes and at ages ranging from 18 months to 5 years. The manner and suddenness of the deaths strongly suggested that the heart was involved. A variety of effects of vitamin E deficiency have been reported in different species of animals, muscular dystrophy in some form being the most common. Recently Houchin and Smith (*3*) produced muscular dystrophy in vitamin E-deficient New Zealand white rabbits 5 weeks of age. They found such animals to be highly susceptible to the action of the posterior pituitary extract, being killed by much smaller doses than were easily tolerated by controls receiving α-tocopherol. The dystrophic rabbits were, however, more resistant to normally lethal doses of cardiac glucosides. Radiographic examinations of the thorax showed the probable existence of cardiac dilatation. They concluded that the sudden death which occurs in advanced cases of muscular dystrophy is due directly to cardiac failure.

The electrocardiograph is constantly being used in the study of heart conditions in human subjects. That it can be put to similar use with the bovine has recently been shown in the comprehensive studies of Alfredson and Sykes (*1, 2, 4*) and Sykes and Moore (*5*). With these facts as a basis, beginning on 2 November 1945 and at monthly intervals or oftener thereafter, electrocardiographs were obtained on all animals on experiment. The instrument used and methods employed were essentially the same as those of Alfredson and Sykes (*1*).

Selected recordings indicating the progressive changes that occurred in the cardiac cycle of E541 are presented in Fig. 1. This heifer is the only animal that has died since the electrocardiogram recordings were started. Her dam and sire were both raised on vitamin E-free rations and died suddenly in the same manner as their daughter. E541 was born on 8 July 1944, was bred on 19 February 1945, and calved normally on 27 November 1945, when less than 17 months old. She died suddenly on 4 April 1946.

Study of the series of electrocardiograms obtained on this animal reveals that a gradual and progressive change occurred, the later recordings showing definite indications of the presence of cardiac abnormalities. The first definite changes appear in the recordings of 21 December 1945, as shown by an increase in P–R interval, a condition which persisted throughout the remaining records. The QRS complexes in Leads II and III also were changed, the

[1] Published with the approval of the director as Paper No. 2307, Scientific Journal Series, Minnesota Agricultural Experiment Station.
[2] The authors express their sincere thanks and appreciation to Joseph F. Sykes, Bureau of Dairy Industry, U. S. Department of Agriculture, for his assistance and aid in interpreting the electrocardiograms.

potential in Lead II was reduced, and the QRS in Lead III changed from an RS type to an R type, an indication of axis deviation.

A clearly apparent increase in the QRS interval appeared in the record of 19 March 1946. The QRS in Lead II also changed from an RS type to an R type. In the record of 26 March 1946 the potential of the various deflections has decreased and remains so in the subsequent recordings.

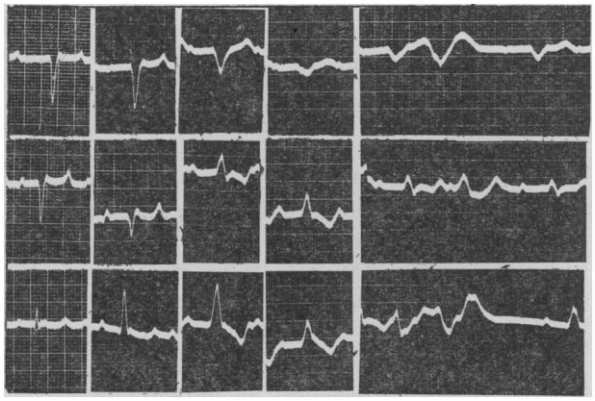


FIG. 1. Electrocardiograms of E541 on dates indicated. (Leads I, II, and III, top to bottom in order.)

In general, the electrocardiograms obtained on this animal appear to show a decreased functional activity of the myocardium in the terminal stages of the deficiency, as indicated by the decrease in the potential of the deflection of the QRS complex and by the increase in duration of the P–R, QRS, and Q–T intervals. The extra systoles which are apparent in the last record indicate dissociation of atrial and ventricular impulses and possibly damage to the conducting tissue. As has been stated, there also was a change in the electrical axis of the heart as the deficiency progressed.

Microscopic studies of heart sections, especially involving the Purkinje network of this and other animals in the study, are being made. It can be stated, even though this work has not been completed, that definite abnormalities have been noted. Atrophy and scarring of the cardiac muscle fibers is clearly indicated. An increase in cellular elements is noted, in some instances strikingly resembling, though smaller than, the Aschoff nodules seen in human endocarditis.

### References

1. ALFREDSON, B. V., and SYKES, J. F. *Proc. Soc. exp. Biol. Med.*, 1940, **43**, 580.
2. ALFREDSON, B. V., and SYKES, J. F. *J. agric. Res.*, 1942, **65**, 61.
3. HOUCHIN, O. B., and SMITH, P. W. *Amer. J. Physiol.*, 1944, **141**, 242.
4. SYKES, J. F., and ALFREDSON, B. V. *Proc. Soc. exp. Biol. Med.*, 1940, **43**, 575.
5. SYKES, J. F., and MOORE, L. A. *Arch. Path.*, 1942, **33**, 467.

## Influence of Purified Lignin on Nitrification in Soil [1]

JAMES E. FULLER
*Massachusetts Agricultural Experiment Station*
*Amherst, Massachusetts*

The study reported here was preliminary to a more extensive study planned to investigate the effect of plowed-under crop residues on the nitrifying process in soil. The object of this preliminary study was to determine the effect of purified lignin on the nitrification of dried blood and of ammonium sulfate in soil.

It is an accepted fact that plant residues of high lignin content decompose slowly in soil because of the resistance of lignin to decay; and lignin in soil has been found to interfere with the natural process of breaking down other organic matter. In particular, lignin depresses protein decomposition. Among the authorities who may be cited in support of this contention are Waksman and Iyer (*7*), Waksman and Hutchings (*6*), and Osugi and Endo (*3*).

In the first of these references the statement is made that the action is not toxic but is an interaction between lignin and protein which results in the formation of a complex "humus nucleus" of lignin and protein. In the second reference it is stated that lignin acts as a buffer to absorb $NH_3$ and combines with protein to form a complex that is highly resistant to decomposition. Smith and Brown (*4*) state that lignin does not possess antiseptic property but that it does decompose very gradually; while Norman (*2*) states that isolated lignin apparently has bacteriostatic action.

### EXPERIMENTAL METHOD

The purified lignin employed in this study was an "alkali" lignin prepared by treating ligneous plant residue with sodium hydroxide, followed by electrodialysis of the product. The author is indebted for its preparation to Emmett E. Bennett, of the Massachusetts Agricultural Experiment Station.

The soil employed was Connecticut Valley sandy loam. The plot from which the soil was taken had been used previously for the cultivation of tobacco, but had been allowed to lie fallow during the season in which the soil was taken in the late summer for this investigation.

The soil was brought into the laboratory, where it was air-dried and screened through a 40-mesh screen. Following determination of its water-holding capacity, 100-gram quantities were put into glass tumblers and materials added as follows: calcium carbonate; calcium carbonate and mannite; calcium carbonate, mannite, and dipotassium phosphate to furnish

[1] Contribution No. 571 of the Massachusetts Agricultural Experiment Station.