REPORTS

THE AMERICAN MUSEUM OF NATURAL HISTORY[1]

A GRATIFYING increase in visitor attendance and museum membership, the completion of many important exhibits, a splendid output of scientific publications and many additions to museum collections make 1941 a year of important progress. Merely to glance at the contributions of the scientific, educational and administrative departments to this annual report is to appreciate the extent and immense value of the work carried on in this institution.

Early in the year the trustees, through a Survey Committtee, commenced an investigation into the museum, and this work will be carried on by the Plan and Scope Committee of the scientific staff. Important changes in trustee and staff organization are being made to enable the museum not only to move towards a definite plan of development but to operate more efficiently within its limited budget. In these changes one salient fact is recognized, that the scientific staff gives the museum its importance not only in the fields of natural science but in general public recognition. The great collections, the exhibits, the educational work in schools and colleges all alike must be based upon the highest scientific standard and knowledge, which can come only from the men and women who compose the scientific staff. Better to enable this group to work, freely to express itself, and to create, develop and carry out great museum plans is the important aim of the trustees. Our scientists fully realize that the "ivory tower" aspect of science is a thing of the past, and that the whole work and development of our institution must be integrated with the life of the community and the nation.

This nation is dedicated to the principle of enlightening its citizens—free minds, not closed minds—free search for knowledge, not propagandized thought. Our great museums are repositories for knowledge; they not only germinate free thought but minister to man's insatiable desire to know more about himself and the world. Museums are one of the important social agencies wherein man develops his spiritual outlook, and in the total war in which this country is engaged the spirit of a free people must be nourished.

Concerning the war effort it is interesting to learn that the scientific staff is uniquely qualified to provide information for various governmental agencies and invaluable data for our military and naval forces. Thus, the museum will provide vital information on parasites prevalent in war; the importance of insects in war; rodent disease carriers; the distribution and habits of, and safeguards against, poisonous snakes; illustrations of tests used to determine the fitness of soldiers; the war terrain of various parts of the globe which have been studied and visited in person by our scientists and explorers; descriptions of inhabitants and tribal customs, of flora and fauna; charts of ocean currents in the Caribbean and other waters, and other topics. Of aid to pilots and ocean navigators is our Hayden Planetarium course in celestial navigation. Research conducted by the museum in past years provides knowledge of marine products useful in war time as well as marine forms dangerous to shipping. Knowledge of nature's incomparable camouflage system is useful.

The department of education, in addition to greatly extending its service within the museum, is planning the creation of portable school museums to be circulated in the New York area, this work to be done in cooperation with other museums receiving city aid; establishment of "Hobby and Craft Development Centers"; establishment of "Community Museums"; integration of museum materials to illustrate various aspects of war areas; and organization of a radio series dealing with the relation of natural science to war.

Above all, the museum is a house of refuge from the stress of wartime existence and as such will continue to provide relaxation, enjoyment and inspiration for an ever increasing number of people.

On behalf of President F. Trubee Davison, who is on active war service, and the Board of Trustees, I wish to express our deepest appreciation to the many hundreds of people who have given generously of their time, effort and means to carry forward the work of the institution.

A. PERRY OSBORN,
First Vice-president

[1] Annual report of the president to the trustees of the American Museum of Natural History and to the Municipal Authorities of the City of New York.

SPECIAL ARTICLES

THE RELATION BETWEEN NUCLEIC ACID AND GROWTH*

RECENT work employing isotopic techniques emphasizes that most tissue constituents undergo continuous synthesis and degradation. In view of the great biological stability of chromosomes in contrast to the variability of most other visible cell constituents, it is of interest to know whether their com-

* This is reprint No. 553 of the Cancer Commission of Harvard University.

ponents show relatively greater chemical stability as well.

Several investigations have recently been made on the turnover of nucleoproteins and nucleic acids in normal and malignant tissues, using radioactive phosphorus as a tracer. Hahn and Hevesy[1] found a slow but appreciable turnover of nucleic acid phosphorus in all rabbit tissues studied. In the case of normal rabbit liver two thirds of the nucleic acid molecules were unchanged after fifty days, whereas all other forms of organic phosphorus were entirely renewed in the course of a few days. Marshak,[2] in experiments with isolated nuclei, found a rapid turnover of phosphorus in the protein fraction of lymphoma and of resting liver, indicating to him a rapid synthesis and breakdown of nucleic acids in the nuclei of these tissues. The accumulation of P^{32} in lymphoma nuclei and the increment over resting liver observed in regenerating liver, he ascribes to mitotic activity. Tuttle, Erf and Lawrence[3] noted that the turnover rate of P^{32} in the "nucleoprotein fraction" of leukemic infiltrated mouse tissues was three to four times higher than in corresponding normal mouse tissues.

In the present experiments, 63 pure strain Slonaker rats weighing between 150 and 200 grams were injected intraperitoneally with neutral sodium phosphate containing 15 to 30 microcuries of radioactive phosphorus (P^{32}). Thirty of these animals were subjected to partial hepatectomy 24 hours before P^{32} injection. This interval was chosen because we have shown[4] that it takes this long for mitotic activity to begin. The rats were exsanguinated under ether anesthesia at six intervals between 6 and 72 hours after injection. For each determination the livers of three rats were pooled and ground in ice-cold saline. A small aliquot of the resulting liver protein solution was precipitated with cold 8 per cent. trichloracetic acid. This precipitate, subsequently freed of phospholipids,[5] we have called "total protein," and this corresponds to the "nucleoprotein" of Tuttle *et al.*,[3] and Kohman and Rusch.[6] From an aliquot of the trichloracetic acid filtrate, inorganic phosphorus was precipitated with an ammoniacal solution of magnesium and ammonium nitrates. Nucleic acid was isolated from the rest of the original liver protein solution by one of two procedures, Levene's[7] and Hammarsten's,[8] which was adapted to liver by omitting the calcium chloride precipitation. The protein remaining after the latter separation of nucleic acids is then freed of phospholipids[5] and termed "protein residue." All these fractions have been analyzed for P^{31} and P^{32}; results have been expressed as specific activities (P^{32}/P^{31}) of each fraction relative to the specific activity of the inorganic fraction of the same tissue.

The results of our experiments on resting liver (Fig. 1) show that the turnover of phosphorus in the nucleic

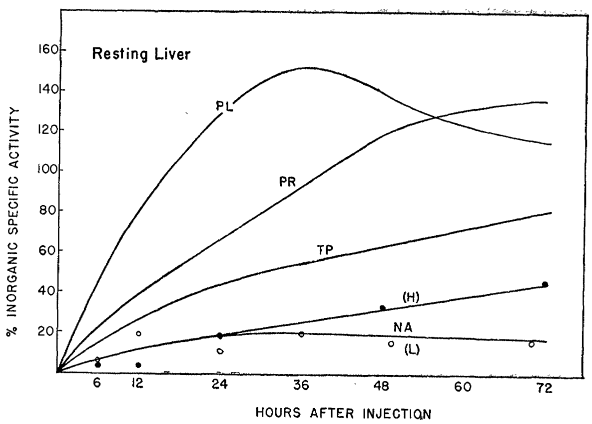

FIG. 1. Resting rat liver. Specific activities of phosphorus fractions at various time intervals after P^{32} injection, expressed as per cent. of the liver inorganic phosphorus specific activity. PL—phospholipids; PR—protein residue; TP—total protein (trichloracetic acid precipitate, free of phospholipids); NA—nucleic acids: (L) obtained by Levene's procedure (open circles); (H) obtained by Hammarsten's method modified (closed circles).

acid fraction is very much less than in any other phosphorus-containing fraction. The "protein residue" has a rapid turnover of phosphorus, distinguishable from the slower rate of nucleic acid and from the faster rate of phospholipid. The "total protein," which contains both nucleic acid and "protein residue," has a rate of turnover intermediate between the two, and examination of Fig. 1 will show that only about half the "total protein" phosphorus is nucleic acid phosphorus. Other writers have assumed that nearly all the phosphorus of the trichloracetic acid precipitate (when free of phospholipids) is contained in the nucleic acids.[3, 6]

In regenerating liver, however (Fig. 2), the increased P^{32} uptake by nucleic acid is of an order

[1] L. Hahn and G. Hevesy, *Nature*, 145: 459, 1940.
[2] A. Marshak, *Jour. Gen. Phys.*, 25: 275, 1941.
[3] L. E. Tuttle, L. A. Erf and J. H. Lawrence, *Jour. Clin. Invest.*, 20: 57, 1941.
[4] A. M. Brues, D. R. Drury and M. C. Brues, *Arch. Path.*, 22: 658, 1936.
[5] Proteins were freed of phospholipids by successive 24-hour extractions with 1: 3 alcohol-ether, hot alcohol and 1: 3 alcohol-ether.
[6] T. P. Kohman and H. P. Rusch, *Proc. Soc. Exp. Biol. Med.*, 46: 403, 1941.
[7] P. A. Levene and L. W. Bass, "Nucleic Acids," p. 299, 1931.
[8] E. Hammarsten, *Biochem. Z.*, 144: 383, 1924.

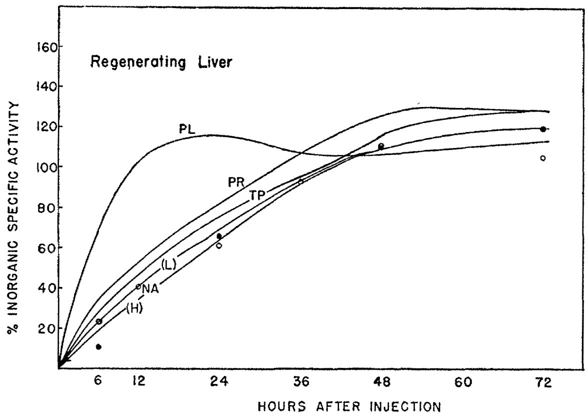

FIG. 2. Regenerating rat liver. Specific activities of phosphorus fractions at various time intervals after P^{32} injection, expressed as per cent. of the liver inorganic phosphorus specific activity. The symbols are the same as in Fig. 1.

of magnitude which can be accounted for by the synthesis of nucleic acid in the formation of new cells. The "protein residue" here apparently has the same rate of turnover as in resting liver, indicating little if any relation to growth. The increased rate of turnover in the "total protein" is therefore due wholly to the higher uptake by its nucleic acid component, confirming Marshak's interpretation on nuclei.[2]

Our results serve to point out the discrepancies between the results of Hahn and Hevesy[1] on nucleic acid and those of Marshak,[2] Tuttle *et al.*[3] and Kohman and Rusch.[6] We have confirmed the observation of the former workers that the turnover of nucleic acid in non-growing liver is very slow. The higher turnover rates found by analyses of "total protein"[3, 6] are not necessarily representative of the nucleic acid portion alone. The relatively higher turnover found by Marshak[2] in the nuclei of resting liver cells probably depends upon fractions of nuclear phosphorus other than nucleic acid phosphorus. Our methods do not distinguish cytoplasmic from nuclear nucleic acids, and some evidence has been obtained that the former have a higher rate of phosphorus turnover than the latter.[9] Thus the resting turnover of nuclear nucleic acids may be even lower than shown by our figures.

The present results lend chemical confirmation to the belief that the nucleus is the stable element in the cell, and point to the nucleic acid component as a compound ensuring this stability. Changes in the more labile compounds within the cell can readily occur through shifts in the steady state, in which rapid synthesis and degradation of these compounds are balanced. In the case of nucleic acids, such continuous turnover occurs very slowly, while synthesis takes place rapidly during growth. This distinguishing characteristic of nucleic acids may be of great importance for the mechanism of growth.

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[9] A. M. Brues, M. M. Tracy and W. E. Cohn, unpublished data.

ISOLATION OF A FILTERABLE VIRUS FROM CHICKENS AFFECTED WITH "BLUE COMB" DISEASE

FOR the past several years poultry pathologists throughout the Northeast have repeatedly encountered a disease entity in domestic chickens, and to a lesser extent turkeys, of unknown origin. It is referred to as blue comb, pullet disease, "X" disease and several other such terms referring to the symptoms exhibited or the conditions or time of encounter. Jungherr and Levine[1] have given a detailed description of the gross and microscopic lesions of the disease as well as their observations on its epidemiology and mortality rate. All attempts, with the possible exception of one by Bullis,[2] to transmit this condition from one bird to another of similar age have failed.

At the University of New Hampshire Agricultural Experiment Station in September, 1941, the writer had the opportunity of observing the course of the malady in two flocks in which the attack was extremely acute and severe. Many of the birds were found dead without having been observed sick; others died after an illness of only a few hours. From the blood stream of such acutely affected birds from both flocks we have been able to obtain a filterable agent that grows readily on the chorio-allantoic membrane of chick embryos. One strain has been carried through 56 transfers made at 72- or 96-hour intervals and the other strain through 39 such transfers. A third strain obtained from the eggs of an infected flock is now in its seventh transfer.

When the infected chorio-allantoic membrane, embryo or embryonic fluid are injected into susceptible chickens they, after 84 to 96 hours, become somewhat depressed and cyanotic. Death has not been produced by such an inoculation. If the inoculated birds are sacrificed at the end of 96 or 120 hours the following gross lesions may be observed; subcutaneous edema, generalized icterus, hemorrhages into the skeletal muscles, marked congestion and swelling of liver and kidneys, collection of urates in ureters, petechia-

[1] Erwin Jungherr and J. L. Levine, *Am. Jour. Veterinary Research,* 2: 4, 261–271, 1941.
[2] K. L. Bullis, personal communication, 1941.