The results obtained in the present study suggest that the erythrocytes of other hereditary hemolytic anemias be examined for the presence of abnormal hemoglobins. This we propose to do.

Based on a paper presented at the meeting of the National Academy of Sciences in Washington, D. C., in April, 1949, and at the meeting of the American Society of Biological Chemists in Detroit in April, 1949.

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The American Philosophical Society

Abstracts of Papers Presented at the 1949 Autumn Meeting, Philadelphia, Pennsylvania

Historical Botanical Collections of the American Philosophical Society and the Academy of Natural Sciences of Philadelphia

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The Academy of Natural Sciences of Philadelphia is the depository of the largest series of early botanical collections preserved in the New World. These are plants gathered either in the latter half of the 18th or the first third of the 19th century, and they belong in equal degree to the Academy itself and to the American Philosophical Society, which deposited its collections with the Academy in 1897. Leading series are those from Francis Masson, who was in South Africa with Thunberg from 1786 to 1795 (ANSP); from Antoine Poiteau, in Haiti from 1796 to 1800 (ANSP); from Henry Muhlenberg, assembler from about 1780 to 1815 of the largest early herbarium in our country (APS); from Benjamin Smith Barton, at University of Pennsylvania from 1789 to his death in 1815, with collections made by John Wood in Australia in 1788, by Frederick Pursh in Virginia and elsewhere in 1806 and 1807, and by Meriwether Lewis on the Lewis and Clark Expedition from 1805 to 1807 (APS, but Pursh, Lewis, and other collections studied by Pursh in England are in part at ANSP); from Thomas Nuttall, over most of the United States and westward from 1807 to 1840 (ANSP, but earliest in APS); from William Baldwin in Georgia and Florida in 1815 to 1818 (ANSP and APS); and from Lewis David von Schweinitz, who was in the eastern United States from 1812 to 1834, and who made the earliest great American collection of Fungi (ANSP). These collections antedate by many years the building of great herbaria elsewhere in this country. One wonders why, after such a brilliant beginning, taxonomic investigation (other than that incidental to the amassing of personal herbaria) should have all but disappeared from Philadelphia by the middle of the 19th century.

Some Approaches to the Study of the Metal Requirements of Microorganisms

S. H. Hutner, ***Haskins Laboratories***

Knowledge of the inorganic requirements for life, conveniently studied in microorganisms, lags behind that of organic nutrition. The discovery that Vitamin B_{12} (the antipernicious anemia factor) contains cobalt has stimulated interest in the identification of the trace elements required for life and their role in metabolism. Such studies are limited or impracticable until deficiency states for these elements can be induced artificially. The case of Vitamin B_{12} illustrates these difficulties. The algal flagellate *Euglena gracilis* requires Vitamin B_{12}, and it is calculated that formation of one organism requires about 4,800 molecules of B_{12}, or 4,800 atoms of cobalt.

On the assumption that the total cobalt required by the organism is contained in B_{12}, it is calculated that the known cobalt contamination (0.001%) of the iron added to the culture medium furnishes cobalt in at least a 33-fold excess. Iron itself is a relatively minor ingredient of the culture medium.

The hemoflagellate *Herpetomonas culicidarum*, which requires hemin as a growth factor, poses an analogous problem: Does the iron found in hemin represent its total iron requirement? As the iron requirement for aerobic forms is far greater than the cobalt requirement, it would seem good strategy to study first the hemin-iron relation in *Herpetomonas* before going on to the more difficult B_{12}-cobalt problem. The methods developed for solving these problems should prove applicable to identifying additional essential elements of the transitional series, should such elements be required.

The fundamental interest of such studies is underlined by the fact that vitamin B_{12} is concerned with the synthesis of desoxyribosenucleic acid, a substance bearing an intimate relation to the gene.

Varieties of Economic Law and Their Limiting Factors

John M. Clark, *Columbia University*

The material of economics, whether we like it or not, is largely indeterminate. Normal spending responds to changing income; but total normal spending (including capital outlay) may temporarily vary more than an income does, making income unstable and indeterminate. Bargaining units have much latitude, making prices and wages indeterminate, and bargaining practices evolve. Individual economic choices, besides being indeterminate, deal with ultimate and incommensurable human values.

Economists used to tell politicians what must happen under "economic law," despite political efforts to interfere. Now it seems more nearly true that politicians decide what is to happen, leaving economists speculating as to consequences, and whether or not actual policy is fatally unsound.

I have three suggestions for making analysis more nearly realistic. First, that we deal frankly with the specific content of human values—for example, health—instead of with abstract curves of choice in theoretical markets. Second, that wherever analysis deals with the kind of relations expressed in lines on graphs—for example, demand curves or cost curves—we turn the lines into zones or bands with width representing the degree of indeterminateness that exists. Then a maximum point or a point of intersection might become a wide range, within which the actual outcome would be decided by other factors than those expressed in the curves. This should enforce active study of these other factors, usually neglected. Third, that economics should frankly investigate what is sound, by standards which it should define—for example, "What should a wise government do about consumers' freedom of choice and why?" Any reasonable answer to this would by-pass existing theories built on refining inferences from utility curves or indifference curves.

This kind of analysis should produce, not fictitiously accurate results, but hypotheses calling for verification, thus bringing deductive thinking and inductive verification closer together.

Day Book of an Education: William Shippen's Student Days in London (1759–60) and His Subsequent Career

Betsy C. Corner, *Baltimore, Maryland*

Details about William Shippen, Jr.'s medical education had been entirely lacking until the discovery of a little diary he kept while a student in London (1759–60) was made unexpectedly some years ago by J. Hall Pleasants, of Baltimore, in whose safekeeping this 18th century manuscript has ever since remained. Through his courtesy and generosity, this little diary has recently become available for study.

In 1759 William Shippen, Jr. was enrolled at St. Thomas's Hospital, London, as a student in surgery. He also attended special lectures in midwifery, and he profited especially from intensive study of anatomy in the anatomical school established by John and William Hunter, two remarkable investigators of great importance in the history of medicine.

Shippen later studied in Edinburgh for a year and received his M.D. from the University of Edinburgh in 1761. He returned to Philadelphia in 1762 and almost immediately began to give a course in anatomy modeled upon the instruction he had received in London. To his credit, he transplanted from English to American soil not only the technical methods he had learned from the Hunters in their anatomical school, but the spirit of their experimental approach to the problems of human structure and of childbearing which were their special consideration.

Dr. Shippen's introductory lecture to his course on anatomy, given on November 11, 1762 at the State House in Philadelphia, marked the beginning of medical instruction of academic standard in the American colonies, and it set the pace for the future development of medical education in this country. Shippen also established the first classes for instruction in obstetrics, open to both sexes, in this country and started a small hospital for the lying-in care of poor women and the instruction of students in obstetrical procedure. That same year, 1765, he received his appointment as professor of anatomy and surgery in the medical department of the College of Philadelphia, the second medical professorship created by the trustees. His connection with the medical school was continuous until 1808 and for a longer time than that of any other member of the faculty of that period. Dr. Shippen is of special interest to the American Philosophical Society because he was elected to its membership in November 1767—182 years ago.

"Inanna's Descent to the Nether World": A New Tablet

Samuel Noah Kramer, ***University of Pennsylvania***

Some eight years ago, in the spring of 1941, the writer read before the American Philosophical Society the then available text of the Sumerian myth "Inanna's Descent to the Nether World." It had been pieced together in the course of several years from thirteen clay tablets and fragments located in the Istanbul Museum of the Ancient Orient and in the University Museum of the University of Pennsylvania. The poem, the writer then pointed out, was still unfortunately incomplete, and he concluded his reading with the hope that sooner or later some of the missing portions would be uncovered. The present paper reports the first and partial realization of this hope; a tablet belonging to the myth has turned up in the Yale Babylonian Collection at New Haven.

It contains 92 lines of text, and its latter half carries on the story of the goddess Inanna's resurrection and return to the earth from the point where the texts had previously broken off. Moreover this new material has a rather unexpected significance; it clears up a misconception concerning the Sumerian fertility god Dumuzi—the Biblical Tammuz—which has misled students of Mesopotamian religion for more than half a century. The tablet has been carefully copied by Ferris Stephens, curator of the Yale Babylonian Collection, and has been tentatively translated by the present writer. This paper and the resulting final publication will thus represent a cooperative effort of Yale University and the University of Pennsylvania.

The Physical Distinctions of Man

Adolph H. Schultz, ***Johns Hopkins University***

The physical distinctions of man are numerous and striking, if adult man is contrasted with other Primates at the completion of their growth. Early in life, man and other Primates are indistinct. Nearly all apparently fundamental, qualitative differences between adult man and apes are in reality of a mere quantitative nature, emerging gradually with age in consequence of diverging trends of development or of differing intensities in otherwise closely corresponding growth changes. The evolutionary modifications in the development of man include many accelerations as well as retardations which, though seemingly inconsequential, lead to marked peculiarities at the completion of growth.

The list of human distinctions is being constantly revised on the basis of accumulating information regarding the growth processes among Primates and can be newly evaluated by means of comparisons between the specific characters of man and those acquired by the manlike apes. In many bodily features man has remained conservative, not having changed as extremely as some other Primates. The most evident human distinctions are directly correlated with the early adaptations to the erect posture and the later enlargement of the brain. Other significant distinctions of man are connected with his latest evolutionary specializations: the prolongation in the main periods of life and the accompanying alterations in the duration and sequence of various developmental processes. Most characters, claimed as specific for man, do not represent radical innovations, but are merely the result of general evolutionary trends which have also produced very similar, though not as far-reaching, transformations in some or all of the anthropoid apes.

Characters which differ in man and the simian Primates in their average formation are often not truly distinctive, if individual conditions are taken into consideration, since the ranges of variations in many features are surprisingly extensive and can overlap in man and one or another of the anthropoids.

Generally speaking, man is clearly and constantly distinguished from all other Primates by his peculiar *combination* of characters which, singly, are often distinct only in regard to the degree of their specialization or the relative frequency of their occurrence.

These generalizations will be illustrated by discussions of examples of physical features distinctive of man.

The Chemical Combination of Insulin with Muscle and Its Hormonal Regulation

William C. Stadie, ***University of Pennsylvania***

Understanding of the fundamental problems of diabetes must await more complete knowledge than is available now of the chemical or physical mechanisms by which insulin affects the metabolism of mammalian tissues. The most prominent conception is that insulin affects one or more of the tissue enzymes which catalyze the multiple reactions concerned in the metabolism of fat, protein, or carbohydrate. Cell-free enzyme systems prepared from normal or pathological tissues should be ideal for the demonstration of such effects, but few demonstrations of insulin effects on such cell-free systems have been reported and these have been difficult to reproduce.

In sharp contrast, the effects of insulin upon intact cells, either *in vitro* or *in vivo*, have been unequivocally demonstrated by many workers. It is conceivable, then, that intact cellular morphology is a necessary condition for the action of the hormone. In that case, physical effects, such as on permeability, rather than chemical effects on enzymes, must be considered as possible effects of insulin. Irrespective of the precise mode of action, it is highly presumptive that, once having entered the cell, insulin must attach itself to some morphological element. This initial direct combination of insulin with the intact cell might indeed be the initial obligatory reaction required for metabolic activity of the hormone. We[1] have succeeded in demonstrating for the first time that such a chemical reaction occurs.

The demonstration is accomplished in the following

[1] The experimental data discussed here are taken from a paper by W. C. Stadie, N. Haugaard, J. B. Marsh, and A. G. Hills, *Amer. J. med. Sci.*, Sept., 1949.

way: a hemidiaphragm from a normal rat is equilibrated for one minute or less in a medium containing a small concentration of insulin. During this brief exposure to insulin firm combination has occurred with some constituent of the muscle cell, and the combined insulin alters the metabolic pattern of the muscle. This is shown by the fact that invariably the insulinized hemidiaphragm, when equilibrated in a glucose-containing medium, utilizes more glucose and synthesizes more glycogen than an appropriate control.

This phenomenon has been studied in the normal rat under a variety of conditions, and in rats with endocrine abnormalities, or those injected with various hormonal preparations. The results indicate that chemical combination of insulin with muscle is under hormonal control and appears to be an important factor in the regulatory mechanism of carbohydrate metabolism in the normal and diabetic animal.

The Development of Contractility

John S. Nicholas, *Yale University*

The origin of contractility must naturally be a function of the developing embryonic tissue and in many organisms is initially common to many different kinds of tissue. In higher forms, however, the contractile nature of protoplasm is largely localized in muscle tissue, and the other tissues lose whatever contractile powers they may have possessed.

In the rat embryo, muscular movement is first noticed after 15 days of development and the flexions and rotations of the body of the fetus attain a considerable complexity before birth. During this period, as well as in the period before movement, the mesoderm has given rise through differentiation to muscle tissue markedly different from adult tissue, consisting of a loose arrangement free of fibers and with no discrete structures such as those normally described for muscle.

In the past few years there has been a tremendous advance in the study of the chemical nature of muscle and it was decided to investigate the chemical, physical, and morphological character of developing muscle, in order thereby to attain critical information which might be correlated with the contractile process.

The most pertinent studies are those which deal with the liberation of inorganic phosphate in chemically separated fractions of developing muscle at different stages of its differentiation, and the correlation of this activity with the nucleic acid content, the development of the muscle respiratory enzymes, and the appearance of birefringence in the developing muscle.

When embryonic muscle is fractionated, the activity of each fraction develops independently and at different rates. This general finding is similar to that of Shen and Boell on the development of the respiratory enzymes in developing muscle. Apparently definite contribution to the chemistry of contractile tissues is made independently by the separable substances. The development of birefringence pattern antedates the formation of actual contractile tissue by a considerable period—at least 12 hours—and occurs at least 24 hours before the first embryonic striations can be observed. The correlation of these and other factors throws considerable light upon the mechanism of beginning contraction.

Studies on the Development of the Cortex of the Brain

Louis B. Flexner, *Carnegie Institution of Washington*

The aim of these investigations has been to establish how long before birth evidence of function can be found in the nerve cells of the cerebral cortex of the guinea pig and how functional development of these cells is related to their structural and chemical development. On microscopic examination, a series of abrupt changes was observed to occur in the nerve cells two-thirds of the way through gestation. Nerve processes start to grow rapidly, nucleoprotein appears in large quantity in the cytoplasm, and the nucleus ceases to increase in volume. These structural developments are accompanied by several changes. The enzyme, adenylpyrophosphatase, believed by its activity to yield useful energy to the cell, increases sharply in activity to the adult level. The activities of the respiratory enzymes, succinic dehydrogenase, and cytochrome C, responsible in part for the combustion of foodstuffs, also increase rapidly to the adult level. At the same period the nerve cells for the first time are electrically active; electrical potential changes can be recorded from the surface of the brain. These potential changes were demonstrated to arise from the cortex itself by local application of strychnine, which produces typical increase in electrical activity. The onset of this cortical electrical activity appears to be causally related to a sudden increase in the permeability of the nerve cells to sodium. This observation fits the hypothesis, advanced by others, that the potential change which follows the stimulation of peripheral nerve is due to the momentary appearance of a selective permeability to sodium.

It is concluded that the nerve cells of the cerebral cortex of the guinea pig begin to show functional activity about two-thirds of the way through gestation and that structural, chemical, and functional differentiation of these cells occurs at the same time or in rapid succession.

Redwoods—Occidental and Oriental

Ralph W. Chaney, *University of California*[2]

The recently discovered redwood of Asia, *Metasequoia glyptostroboides,* shows relationship to the redwood of North America, *Sequoia sempervirens,* and to the swamp cypress, *Taxodium distichum.* Foliage and cones of the living trees provide characters by which they may be readily distinguished, but for nearly a century there has been confusion in the recognition of fossil specimens.

[2] Research associate, Carnegie Institution of Washington.

Large collections from the Cretaceous and Tertiary deposits of western North America have recently been restudied; criteria have been established for separating fossils of the three genera, and for setting up recognizable species.

During Cretaceous time, and at the beginning of the Tertiary period, *Metasequoia* was abundant at high northern latitudes. Its deciduous habit was well suited to a regime of summer rainfall and lowered winter temperature. With gradual reduction in rainfall and temperature. *Metasequoia* and its associates are recorded from successively more southerly stations, as far south as California; near the end of the Tertiary period it became extinct in North America, probably as a result of a shift to winter rainfall and summer drought. Its failure to survive in the southeastern United States along with *Taxodium*, which is also deciduous, cannot now be explained.

The geologic history of *Sequoia* has been somewhat different because of its evergreen habit. Never as abundant as *Metasequoia*, the ancestors of the California redwood were in past ages largely limited to foothills and to the borders of ancient seas. With the change in rainfall regime during later Tertiary time, *Sequoia* was restricted to the borders of the Pacific; in regions with summer fog it still survives. *Metasequoia* is known to exist only in the interior of China, where heavy summer rainfall is combined with moderate temperatures. Here in valleys so remote that they have not yet been completely deforested by land-hungry farmers, the redwood of Asia appears to be living the last chapter of its hundred-million-year existence.

TECHNICAL PAPERS

Mutual Interaction of Polyelectrolytes[1]

Raymond M. Fuoss and Hussein Sadek[2]

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Polyelectrolytes (*1*), even in the most dilute solution, give regions of high charge density in the neighborhood of each polyion, as a simple consequence of structure. We might therefore expect a strong electrostatic interaction between the fields of polycations and polyanions, which would lead to mutual precipitation. Results are herewith presented which verify this prediction.

In one series of experiments, portions of a dilute solution of sodium polyacrylate[3] were added to a solution of poly-4-vinyl-*n*-*N*-butylpyridonium bromide. Flocculent precipitates formed immediately; at concentrations as low as 10^{-5} normal in bromide ion (about 10^{-8} molar in polyelectrolyte), a distinct turbidity was still visible. The precipitation was followed quantitatively by measuring the turbidity of the mixtures with a Phoenix light-scattering photometer. Fig. 1 shows the results of a typical experiment in which successive portions of 10^{-3} normal polyacrylate solution were added to 40 ml of 25×10^{-6} normal polypyridonium bromide. Up to the equivalence point, the turbidity τ increased linearly with the amount of polyacrylate added; just beyond equivalence, the turbidity increase accelerated sharply, and after a ratio of about 1.5, slowly decreased with further addition of polyacrylate. Fig. 2 is a log-log plot of the turbidity obtained when 1.5 equivalents of polyacrylate were added to 1.0 equivalent of polypyridonium salt, the latter at varying stoichiometric bromide concentrations, *N*. It will be noted that the points fall on a 45° line, showing that the amount of precipitate is proportional to the concentration of the polypyridonium solution from which it was precipitated down to below millionth normal in bromide ion (approximately 10^{-9} molar in polybromide or 0.2 ppm by weight). The lowest concentration corresponds to the present limit of sensitivity of our optical equipment.

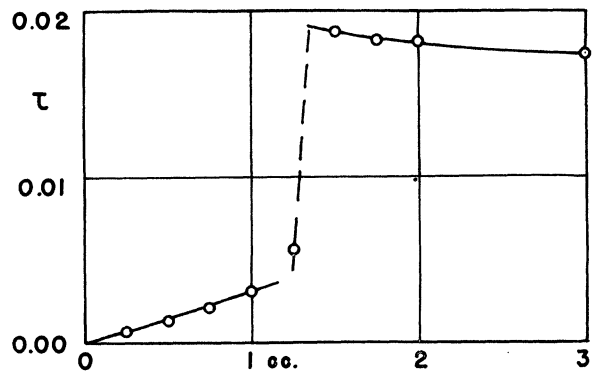

FIG. 1. Turbidimetric titration of polyvinyl-butyl-pyridonium bromide (40 cc of 25×10^{-6} normal) with sodium polyacrylate (10^{-3} normal).

These results may be interpreted as follows: When polyacrylate is added to polypyridonium salt, the latter is initially in excess. Normally, each polyacrylate ion is surrounded by an atmosphere of sodium counter ions; when a polyacrylate ion-plus-ion cloud encounters polypyridonium ions, the strong attractive field between poly-

[1] Project NR 054–002 of the Office of Naval Research.

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[3] We are grateful to the Minnesota Mining and Manufacturing Company for a sample of polyacrylic acid and to the Dow Chemical Company for a sample of sodium polystyrene sulfonate.