to the solubility of high molecular film-forming substances.

The book from start to finish is strictly chemical and the approach to all the subjects is, as the title implies, a study of the chemistry of the processes under discussion. It is replete with bibliographic references inserted at the ends of the various chapters.

The style of the translator is somewhat influenced by an occasional too literal translation of the German, and the general format reveals the influence of the modern requirements of our war economy. The book should be a valuable addition to the libraries of all those who are interested in the chemistry of polymerization and will be particularly welcome to those who have seen the German original and have wished for an English translation.

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MARINE AND AIR NAVIGATION

Marine and Air Navigation. By JOHN Q. STEWART and NEWTON L. PIERCE. 472 pages. Ginn and Company. $4.50.

ALTHOUGH the difference between marine and air navigation is largely one of technique, this is probably the first text to treat both equally. Many students will want to read both parts, yet the reader who wishes to limit his studies to either one will find the two sufficiently well separated to permit this.

The book contains a large number of illustrations and reproductions of charts and government publications. Throughout the book emphasis is given practice rather than theory, with mathematics playing a supporting role and never a leading one. The book is unusually readable for a text and for piloting and dead reckoning navigation is thorough and well organized.

The only fault, if it is one, is the order of presentation of the various parts of celestial navigation. A step-by-step explanation of the simplest method of solution of celestial observations is all that is necessary for the navigator with modern equipment, but it may not be the best way to instill a thorough understanding of the principles which may be needed when the easiest tools are not available.

Despite this feature, which many readers will entirely approve, the book is easily the best general text on navigation that has appeared in recent years.

Basic Marine Navigation. By BART J. BOK and FRANCES W. WRIGHT. 422 pp. Houghton Mifflin Company. Book, $4.50; kit, $1.70.

WRITTEN for the Army Engineer Command, this book gives chief attention to navigation near land. Emphasis is given procedure, and where rules and computational forms suffice, a deeper discussion is omitted. It attempts to develop "an intuitional understanding of the procedures" rather than a theoretical understanding of the principles involved. Included is an interesting and practical chapter on "Navigation in Emergencies," a good chapter on "Marine Meteorology" and one on the principles of the maneuvering board.

Celestial navigation is fully covered, but the chapter on the sextant seems to be out of place and "Navigation by the Sun" and "Navigation by the Stars" are separated as though there were an essential difference between them. Somewhat questionable, also, is the placing of special cases before the usual method of finding a line of position.

Regardless of its weaknesses, this is one of the better recent books on navigation. It is well written and contains a number of excellent illustrations. It is particularly recommended to the person who wants to teach himself. Available separately is a "kit" which supplies the necessary materials for solving the practice problems of the text.

The Theory of the Gyroscopic Compass and Its Deviations. By A. L. RAWLINGS. 182 pp. The Macmillan Company. $3.00.

IN this second edition the author has simplified the mathematics somewhat, but it is still too involved for the average reader.

The book naturally falls into three parts, the first dealing with the principle of the gyroscope, the second giving a description of the various gyro-compasses; the third dealing with the errors of the gyrocompass, as an instrument to indicate true north, and their solution.

Written from the viewpoint of the designer, the book contains much of interest to the non-mathematical reader with a general knowledge of the instrument. It is undoubtedly the most thorough book on the subject.

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SPECIAL ARTICLES

A METHOD OF PROLONGING THE ACTION OF PENICILLIN[1]

THE clinical effectiveness of penicillin has been well established. However, from the standpoint of determining optimum dose, period of time necessary for treatment and of inconvenience both to patient and

[1] From the Penicillin Section, Laboratory Service, Walter Reed General Hospital. The technical assistance of

personnel, present methods[2, 3, 4, 5, 6] of administration are not completely satisfactory.

In this study a method of administration of penicillin is reported which decreases the rate of absorption, prolongs the duration of an effective level in the blood and is of minimum inconvenience to the patient.

Beeswax has been used to prolong the action of histamine,[7] desoxycorticosterone acetate[8] and heparin.[9] rabbits after intramuscular injections. More enduring levels resulted than occur with penicillin in physiological saline, but a greater prolongation was desirable.

Under sterile conditions, 0.75 per cent., 1.0 per cent., 1.25 per cent., 2.0 per cent., 3.0 per cent., 4.0 per cent., 5.0 per cent. and 6.0 per cent. mixtures of U.S.P. bleached beeswax in peanut oil were prepared.

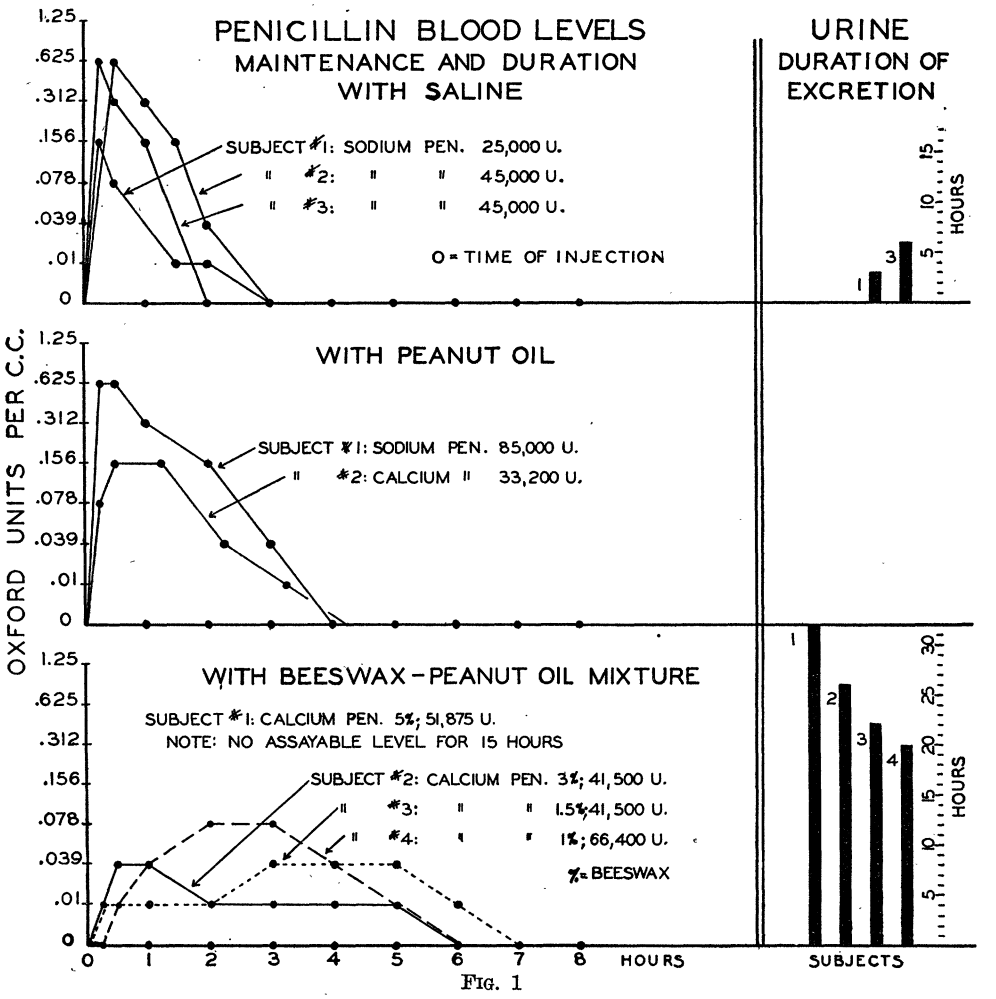

FIG. 1

Prior to the utilization of beeswax, in February, 1944, we had suspended penicillin in refined peanut oil, sesame oil, cottonseed oil, castor oil and protamine zinc in an attempt to produce prolonged action in

Two to 3 cc of the clear warmed beeswax-peanut oil mixture were added with a warm pipette to an ampule of penicillin which had previously been shaken by hand to break the penicillin into as powdery a state as possible. Three to 5 sterile glass beads were then placed in the bottle which was stoppered and shaken by hand for ten to fifteen minutes until the particles of penicillin were well dispersed.

Miss Dorothy Talbot and Technician (4th grade) Minna Levy is gratefully acknowledged.

[2] H. Dawson and G. V. Hobby, *Jour. Am. Med. Asn.*, 124: 611, March 4, 1944.

[3] W. E. Herrell, *Jour. Am. Med. Asn.*, 124: 622, March 4, 1944.

[4] A. L. Bloomfield, L. A. Rantz and W. M. Kirby, *Jour. Am. Med. Asn.*, 124: 627, March 4, 1944.

[5] H. V. Morgan, R. V. Christie and I. A. Roxburgh, *Brit. Med. Jour.*, 515: April 15, 1944.

[6] Unpublished data on observation of 250 cases treated with penicillin at Walter Reed General Hospital.

[7] C. F. Code and R. L. Varco, *Am. Jour. Physiol.*, 137: 225–233, August, 1942.

[8] C. F. Code, R. H. Gregory, R. E. Lewis and F. J. Kottke, *Am. Jour. Physiol.*, 133: 240–241, June, 1941.

[9] J. C. Bryson and C. F. Code, *Proc. of Staff Meeting, Mayo Clinic*, 19: 100, February 23, 1944.

Stability tests[10] on the penicillin in oil and in beeswax-peanut oil mixture show no deterioration in various batches kept at refrigerator, room and 37 degrees C. temperature for 30 to 62 days.

As initial experiments rabbits were injected intramuscularly with 5,000 to 10,000 Oxford units of penicillin contained in 1 cc of beeswax-peanut oil mixture and blood assays[11] were made. Whereas penicillin in saline maintained a level for only two hours, penicillin in beeswax-peanut oil mixture maintained a level for 6 to 12 hours.

Human subjects were then given single injections of 41,500 to 66,400 Oxford units of penicillin intramuscularly. These doses were contained in 2 to 2.4 cc of beeswax-peanut oil mixtures. The figure shows the maintenance and duration of penicillin levels in the blood obtained by the use of penicillin in saline, peanut oil and the various percentages of beeswax-peanut oil mixtures. The figure also compares the duration of excretion of penicillin in the urine after the injection of penicillin in saline and in beeswax-peanut oil mixture. The beeswax-peanut oil mixture delayed penicillin absorption and maintained a level in the blood for 6 to 7 hours. The presence of penicillin in the urine for 20 to 32 hours indicated a persisting level in the blood for that period of time, though not assayable by present methods.

None of the patients complained of local pain or irritation in the region where the penicillin beeswax-peanut oil mixture had been injected. Nothing suggestive of an allergic reaction occurred in any of the subjects.

Gross and microscopic studies of tissues from hamsters which have been injected with the penicillin beeswax-peanut oil mixture are in process of study.

Eleven of twelve patients[13] with gonococcic urethritis have been cured after receiving a single injection of penicillin beeswax-peanut oil mixture.

The detailed accounts of these investigations will be published in the October, 1944, issue of the *Bulletin* of the U. S. Army Medical Department.

SUMMARY

(1) Single injections of penicillin in beeswax-peanut oil mixture will produce and maintain levels of penicillin in the blood for 7 or more hours.

(2) These mixtures have maintained their potency at room, incubator and refrigerator temperatures for 30 to 62 days and show no signs of deterioration to date.

(3) Eleven of twelve patients with gonorrhoea have been cured by a single injection of penicillin beeswax-peanut oil mixture.[14]

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INHIBITION OF β HEMOLYTIC STREPTOCOCCI FIBRINOLYSIN BY TRYPSIN INHIBITOR (ANTIPROTEASE)*

TILLETT and Garner[1] in 1933 discovered that β hemolytic streptococci produce an extracellular substance which is fibrinolytic in that it can liquefy human fibrin. They also found that patients with β hemolytic streptococcal diseases develop a factor which is capable of inhibiting the *in vitro* action of the fibrinolysin. These observations gave impetus to numerous studies on the role of the fibrinolysin in diseases attributable to β hemolytic streptococci and on the development of antifibrinolysin in such patients. Consequently, evidence has been accumulated which suggests that the fibrinolytic potency of the organism plays a role in the pathogenesis of some aspects of hemolytic streptococcic infections.[2]

The mechanism whereby the streptococcal fibrinolysin liquefies solid human fibrin is unknown, although it is stated by some that it is not a proteolytic enzyme since the products of proteolysis are not apparent when liquefaction has occurred.[2] However, it is possible that the liquefaction of fibrin consequent to the action of fibrinolysin is due to some hydrolysis of the protein, the rate of proteolysis being such as to make the measurement of the products a difficult one.

During the course of studies on the significance of antifibrinolysin formation in streptococcal diseases, we found it necessary to evaluate also the significance of serum antiproteases. It soon became apparent that a serum which has a high antifibrinolysin titer also has a high antiprotease (antitrypsin) titer. This lent emphasis to the possibility that the two phenomena are related and consequently, that the streptococcal fibrinolysin is more closely related to proteases than hitherto believed. It is probable that the proper application of Bergmann's method[3] would

[10] Assays were made by the methods of Rammelkamp[11] and Rake.[12] Penicillin assays of the urine were also done by these methods.

[11] C. H. Rammelkamp, *Proc. Soc. Exp. Biol. and Med.*, 51: 95, October, 1942.

[12] G. Rake and H. Jones, *Proc. Soc. Exp. Biol. and Med.*, 54: 189, 1943.

[13] The cooperation of Captain Robert J. Murphy of the V.D. Ward is appreciated.

[14] An additional fifty-three cases have been cured by this method. Data on these cases will be published later with Captain Robert J. Murphy.

* From the AAF Rheumatic Fever Control Program.

[1] W. S. Tillett and R. L. Garner, *Jour. Expt. Med.*, 58: 485, 1933.

[2] W. D. Tillett, *Bact. Rev.*, 2: 161, 1938.

[3] M. Bergmann, "Advances in Enzymology," 1: 63, 1941.