Dirac[2] has constructed a mathematical model of a new particle which has the same charge as an electron but a spin greater than ½. The writer has proposed[3] that this latest prediction of Dirac's represents the newly discovered X particle. This note contains a summary of the properties of this particle to be expected on the basis of this latest Dirac theory.

If we let p_t and p_x represent the energy and momentum—the x component—operators of the wave mechanics, then the equations which describe the properties of the particle moving in the x direction in free space are $(p^2{}_t - p^2{}_x)\ \psi = (m\,c)^2\ \psi$ and $(p_t - A\,p_x)\ \psi = B\ (m\,c)\ \psi$, where A and B are matrices. If the spin of the particle is k units, the Hermetian matrix A is such that $A^2 = k\ (k+1)\ /3\,k^2$. The wave function may be written in the form $\psi = \alpha \exp. \frac{2\pi i}{h}\ (Wt + p_x X)$.

The question naturally arises whether or not for sufficiently high values of the energy W the term containing the mass of the particle m can be neglected. In that case the equations reduce to $(p^2{}_t - p^2{}_x)\ \alpha = 0$ and $(p_t - A\,p_x)\ \alpha = 0$. From the first equation we get $p_t = p_x$, so that the second equation can be written as $p_t\ (1 - A)\ \alpha = 0$. By manipulating the conjugate imaginary equation in the same manner, it can be shown that these equations have a solution only if A is such that $A^2 = 1$. Thus the mass term can be neglected legitimately for that case in which $k = \frac{1}{2}$ or expressed non-mathematically for the case of the ordinary electron. On the other hand, for the new X particle, the energy can never become so great that the mass calculated from the Einstein relation $W = m\,c^2$ is large compared to the rest mass m. Some very interesting properties of this particle can be deduced from this fact. 1. The ionization of a very high energy particle must be large compared to that of an ordinary electron of the same energy because the large value for the rest mass requires that the velocity never becomes comparable with the velocity of light. 2. The radiation will always be small in comparison to that of the same standard, the ordinary electron, because of the high value for its rest mass. This calculation is made under the restriction that the change in mass in this process can be neglected. 3. The X particle through a spin transformation can change its mass into kinetic energy at a nuclear collision. In this process a number of neutrinos sufficient to take care of the change in spin must be generated. The newly formed charged particle, in the limiting case an ordinary electron, will take the residual energy from this process off in the form of kinetic energy.

Properties of this nature for the X particle are perfectly consistent with the data on the new particle accumulated up to the present time. Exact analytical formulae for these various properties must wait until a rigorous solution of the spin matrices for large values of k is found. It is probable that the theory of ideal factors[4] will contain the key to their solution.

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[2] P. A. M. Dirac, *Proc. Roy. Soc.*, 155, July, 1936.

[3] A. Bramley, *Phys. Rev.* (A), 22, Madison meeting, June, 1937.

[4] Weitzenbock, "Invarianten-theorie," Groningen.

ADMINISTRATION OF OESTRONE TO YOUNG ALLIGATORS

RELATIVELY little study has been made of the effects of female sex hormone injections into reptiles. Kehl[1] stated that the administration of folliculin to sexually immature female turtles was followed by oviduct hypertrophy. Turner[2] injected theelin into adult male skinks; the result was a decrease in testis weight, a proliferation of germinal cells and a hypertrophy of the epididymides. Dantchakoff[3] introduced folliculin into incubating lizard eggs. Examination of the lizards after hatching revealed larger oviducts in both male and female experimental animals than were found in female controls. Dantchakoff stated that the control male oviducts disappeared before hatching. The injections also inhibited the development of the penis.

In the work to be reported here, 22 immature alligators of both sexes, 15 months old when injections began, comprised the experimental group. Sex can not be distinguished externally at this age. Eighteen of the animals were injected with a total of 9,300 R.U. (46,500 I.U.) of Progynon[4] each, evenly distributed over an 80-day period, while the remaining 4 animals received lesser amounts of the hormone. A similar group of 22 alligators served as controls.

Autopsy two days after the last injection revealed that there were 9 males and 13 females in the experimental group, and 7 males and 15 females in the control group. The oviducts of the injected females were so greatly hypertrophied as to distend the abdomen. Vestigial male Müllerian duct segments, difficult to locate even microscopically in normal males of this age, had so greatly hypertrophied under experimental treatment as to be readily visible macroscopically as small nodules, one of which lay just lateral to each testis in the injected males. The cloacae and penes or clitorides of the injected animals were not visibly affected.

Histological study of the testes showed that the persistent isolated areas of germinal epithelium, equivalent to a vestigial cortex and lying external to and penetrating the tunica albuginea of the normal testis

[1] R. Kehl, *C. R. Soc. de biol.*, 105: 512–13, 1930.

[2] C. D. Turner, *Biol. Bull.*, 69: 143–58, 1935.

[3] V. Dantchakoff, *C. R. Acad. des Sci.*, 205: 424–27, 1937.

[4] Supplied through the courtesy of Dr. Erwin Schwenk, of the Schering Corporation.

at this age, had in the experimental males undergone an average hypertrophy (with wide individual variation) of 355 per cent. as estimated by the camera lucida paper tracing method. The testicular medulla was not significantly affected. In the experimental females the ovarian cortex showed an average increase in volume of 94 per cent., due chiefly to a multiplication of oogonia, as compared to normal cortex. The increase in experimental ovarian medullary volume was not judged to be statistically significant. Microscopic examination indicated that the striking hypertrophy of the oviducts and the male Müllerian duct rudiments in the injected animals was due largely to an extensive growth of the mucosa, which often projected into the duct lumen in prominent longitudinal folds. The muscular strata of the experimental oviducts were also precociously developed as compared to those of the controls. Shell glands were not identified. The Wolffian ducts and mesonephroi of both sexes were unaffected.

Evidence of some degree of bisexuality in the normal females was found in the retention of fully formed Wolffian ducts many months after the mesonephros had ceased to be a secretory organ and in the persistence, in the posterior portion of the ovary, of a testis-like area of medulla lacking the typical cortical investment. This atypical medulla was not significantly affected by oestrone treatment. A degree of bisexuality in the normal male was indicated by the retention of vestigial Müllerian duct segments and by the persistence of fungiform cortical areas on the testis.

It is concluded from the experimental data that oestrone, when administered to sexually immature alligators under the conditions described: (1) produces testicular and ovarian cortical hypertrophy and (2) selectively stimulates the oviducts and male Müllerian duct segments without affecting the Wolffian ducts of either sex, and that (3) neither the oestrone nor the hypertrophied testicular and ovarian cortical components inhibit the testicular and ovarian medulla. An extended report of this experiment will be published later.

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THE FLAGELLATION OF BACTERIA[1]

NEARLY twenty years ago it was pointed out[2] that the apparent occurrence of both monotrichic and peritrichic species among the legume nodule bacteria might be explained on the assumption that all species have actually several flagella but appear monotrichic in young preparations. Attention was called to the fact that even with those species where only one flagellum can be found, it is as apt to be attached at the side of the cell as at the pole.

Smith and Brown[3] have published illustrations showing that *Bacterium radiobacter* is not unlike some of the nodule bacteria in this respect, appearing sometimes with a single flagellum which may be either polar or lateral, and sometimes with two to four peritrichic flagella. Verification of this observation has been secured by A. W. Hofer (of the writers' laboratory) and is to be published shortly. This fact, together with similar statements in the literature concerning the violet chromogens and other bacteria, has suggested that there may be a type of flagellation distinct from polar flagellation, on the one hand, and even from true peritrichic flagellation, on the other. Accordingly, a collection of various soil and water non-spore-formers has been secured and a series of flagella stains made from all of them.

The results in detail will be presented elsewhere. Here we wish merely to call attention to the fact that there does seem to be evidence of three distinct types of flagellation. Fig. 1 shows a typically peritrichic

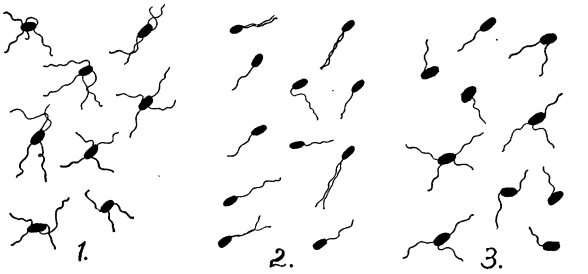

FIG. 1. *Escherichia coli* Castellani and Chalmers, showing true peritrichic flagella. FIG. 2. *Bacterium parvulum* Conn, showing polar flagella. FIG. 3. *Bacterium radiobacter* Löhnis, showing possibly degenerate peritrichiate arrangement of flagella.

organism. Fig. 2 shows an organism with definitely polar flagella, most cells being monotrichic but a few showing two flagella at one pole. Fig. 3, on the other hand, shows the type of flagellation which is now under consideration. It is apparently a degenerate form of peritrichic flagellation, but the flagella are so few in number and all but one so often missing that unless an extensive study is made one might easily be tempted to call such a culture unquestionably monotrichic.

Attention is called to this point because it is felt that considerable confusion has occurred in the classification of bacteria in the past from trying to make a rigid separation between peritrichic and monotrichic

[1] Approved by the Director of the N. Y. State Agricultural Experiment Station for publication as Journal Paper No. 258, March 2, 1938.

[2] H. J. Conn and R. S. Breed, SCIENCE, 51: 391–2, 1920.

[3] F. B. Smith and P. E. Brown, *Iowa State Col. Jour. Science*, 10: 17–25, 1935.