maximal destruction of red cells occurred at approximately 235 days in both guanacos. We do not know of any species with similar erythrocyte survival times. The elliptical erythrons of Camelidae may be unique in their longevity as compared to the circular, biconcave erythrons of other mammals (*9*).

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References and Notes

1. G. Gulliver, *Phil. Mag.* **16**, 23 (1840).
2. E. Ponder, J. F. Yeager, H. A. Charipper, *Quart. J. Exptl. Physiol.* **19**, 115 (1928).
3. N. I. Berlin, D. C. Van Dyke, C. Lotz, *Proc. Soc. Exptl. Biol. Med.* **82**, 287 (1953).
4. D. Shemin and D. Rittenberg, *J. Biol. Chem.* **166**, 627 (1946).
5. C. E. Cornelius, J. J. Kaneko, D. C. Benson, J. D. Wheat, *Am. J. Vet. Res.* **21**, 1123 (1960).
6. C. E. Cornelius, J. J. Kaneko, D. C. Benson, *ibid.* **20**, 917 (1959).
7. J. J. Kaneko and C. E. Cornelius, *ibid.*, in press.
8. J. A. Bush, N. I. Berlin, W. N. Jensen, A. B. Brill, G. E. Cartwright, M. M. Wintrobe, *J. Exptl. Med.* **101**, 451 (1955).
9. We are indebted to Dr. W. Heuschele and Dr. R. Stader of the San Diego Zoo Hospital for their cooperation. This study was made possible by the Biological Research Institute of the Zoological Society of San Diego, through an Ellen B. Scripps fellowship.

26 February 1962

Occurrence of a Porphyrin Pigment in Streptomycetes

Abstract. The formation of an intramycelial red pigment of coproporphyrin type in submerged cultures of *Streptomyces griseus* and *S. fradiae* was detected. Its production is more intensive in the variants of *S. griseus* Z38 that give a low yield of streptomycin, and in the absence of Fe^{++} in fermentation media.

Despite the growing knowledge of the physiology of actinomycetes, relatively little is known about the chemical nature of their pigments that lack antibiotic activity. Many of the antibiotic pigments of actinomycetes are of the quinonic type (*1*), as are probably some of the nonantibiotic pigments which function as *p*H indicators. Some actinomycetal pigments that possess antibiotic properties, such as holomycin, thiolutin and aureothricin, are relatively simple derivatives of pyrrole (*1*); the orange antibiotic pigment found in a streptomycete related to *Streptomyces ruber* and *S. roseo-distaticus* (*2*) is prodigiosin-like in nature. However, the accumulation of true porphyrin pigments in actinomycetes has so far not been described.

During our study of the physiological relationships of streptomycin biogenesis in *S. griseus* Z38, we have observed the production of a mycelium-bound red pigment that was formed during the submerged cultivation of the organism on a reciprocal and rotary shaker, with a variety of complex and synthetic growth media. During the growth of the organism on Ferguson's (*3*) and other synthetic nutrient media, the production of the pigment was favored by the absence of iron salts. A pigment concentrate was obtained from the 5-day submerged culture by adjusting the *p*H value of the fermentation liquid to 2, separating the mycelium by filtration, and extracting it with an adequate volume of ethyl acetate. This crude ethyl acetate extract, which showed an intense reddish-violet fluorescence in ultraviolet light, was further purified by extraction of the red pigment from ethyl acetate to water at *p*H 6.0 and by repeated extraction to ethyl acetate, after acidification of the aqueous phase to *p*H 5.4. After this process had been repeated four times the pigment was transferred from the acidified aqueous solution to ether and then extracted with 0.1*N* hydrochloric acid. After adjustment of the *p*H of this extract to 2.0 the pigment was again extracted with ether. This final ether extract was evaporated to dryness, which left a purified concentrate of the pigment in the form of a dark violet amorphous residue. The amount of this concentrate was too small for further purification.

The solution of this material in ether showed absorption peaks at 598, 623.5, 569, 527, 499, and 397 mμ in order of increasing intensity, whereas its solution in 0.1*N* HCl showed absorption maxima at 590, 548, and 400.5 mμ. The HCl number estimated by the method of Willstätter (cited in *4*) was 0.09. The pigment was not soluble in chloroform. These results clearly suggest that the pigment is a porphyrin. The analytical data obtained coincide with those given by Jope and O'Brien (*5*), Todd (*6*), and Lemberg (*4*) for coproporphyrin. The formation of this pigment was also markedly augmented during the degeneration, in respect to streptomycin production, of the strain of *S. griseus* Z38. A pigment of a similar type was also found in iron-deficient submerged cultures of *S. fradiae*.

These results show that the formation of porphyrin pigments, known so far in yeasts, fungi, and bacteria (*1*), occurs in actinomycetes as well.

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References and Notes

1. M. W. Miller, *The Pfizer Handbook of Microbial Metabolites* (McGraw-Hill, New York, 1961).
2. F. Arcamone, A. DiMarco, M. Ghione, T. Scotti, *Giorn. Microbiol.* **4**, 77 (1957).
3. J. H. Ferguson, H. T. Huang, J. W. Davisson, *Appl. Microbiol.* **5**, 339 (1957).
4. R. Lemberg, *Fortschr. Chem. Org. Naturstoffe* **11**, 299 (1954).
5. E. M. Jope and J. R. P. O'Brien, *Biochem. J.* **39**, 239 (1945).
6. C. M. Todd, *ibid.* **45**, 386 (1949).
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30 April 1962

Action of Tetanus Toxin in the Cerebral Cortex

Abstract. Injection of more than ten mouse lethal doses of tetanus toxin into cat's motor cortex produces seizures accompanied by cortical electrical convulsive discharges. During the hours preceding onset of large seizures, "antidromic" inhibition of evoked cortical activity is reduced. The similarity of these effects to those observed in spinal cord suggests operation of similar inhibitory transmitters in the two parts of the central nervous system.

Tetanus toxin has a specific pharmacological action in the spinal cord: it progressively reduces transmission at all inhibitory junctions. Since all types of inhibition are equally affected no matter what their central connections (*1–3*), one may infer that the transmitters at such junctions are very similar, or perhaps are the same substance. We have investigated the effects of tetanus toxin on the electrocorticogram and on inhibition in the cerebral cortex. It has been reported recently that cerebral injection of tetanus toxin may produce convulsive activity and foci of electrical discharge (*4*). The prerequisite for a study such as ours is knowledge about a form of synaptic inhibition that occurs in the cortex. This condition is met in the case of "antidromic" cortical inhibition: repetitive stimulation of the bulbar pyramidal tract causes inhibition of spontaneous activity of cortical units (*5*) and of responses to peripheral or cortical stimulation (*6, 7*).

Acute experiments were carried out with cats receiving artificial respiration while immobilized by intravenous injections of Flaxedil. After brain exposure under ether anesthesia the animals were maintained with a long-lasting anesthetic. Details of these methods have been described previously (*8*). Approximately 1 to 10^5 mouse lethal doses of tetanus toxin suspended in 10^{-3} to 10^{-4}