TABLE 1

Subjects	Average per cent. correct				Range in per cent.
	1–100 trials	101–200 trials	201–300 trials	Total	
Alpha	54.0	59.0	63.0	58.7	30–90
Bimba	54.0	57.0	61.0	57.3	30–80
Bokar	54.0	64.0	56.0	58.0	40–80
Frank	58.0	60.0	43.0	53.7	20–90
Lia	53.0	63.0	52.0	56.0	20–90
Total correct ..	54.6	60.6	55.0	56.7	
Total W correct.	52.0	57.2	54.0	54.4	
Total B correct.	57.2	64.0	56.0	59.1	

Behavior in these tests indicated adequacy of motivation, and as a rule diligence of effort to choose the correct box in order to obtain the food. There were many daily series in which success exceeded chance by 20 to 40 per cent., but in no case was perfection of response achieved, even for a single daily series. The degree of success exhibited, together with the behavior of the subjects in making their choices, convince us that some cue or cues, unobservable directly by us, were operative. Among them may have appeared symbolic process representative of white box or black box. But, if this occurred, it is clear that it did not function readily and smoothly, for the subjects obviously worked very hard to adapt to a situation which for the normal human being is extremely easy, and, moreover, they often were much disturbed emotionally. It appears that, whereas the "thereness" of the correct box may readily be responded to by the chimpanzee, the "thatness"—as exemplified by a symbolic process equivalent to rectangular whiteness—is used with difficulty and uncertainty. Nevertheless, it is our opinion, based upon the results of varied and long-continued training experiments, that symbolic processes occasionally occur in the chimpanzee; that they are relatively rudimentary and ineffective; and that our experiments with subjects ranging in stage of development from early childhood to maturity have supplied no convincing evidence of the increase in frequency and functional value of symbolic response with increase in experience and age.

In our findings we consider most significant the evidence that delayed response, in the absence of spatial cues or with misleading cues, is either extremely difficult or impossible for most chimpanzees. This suggests that we may have happened upon an early phylogenetic stage in the evolution of symbolic process. There is abundant evidence that various other types of sign process than the symbolic[9] are of frequent occurrence and function effectively in the chimpanzee.

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[9] C. W. Morris, *op. cit.*, pp. 17*ff.*, and E. A. Esper, chapter 11 in "A Handbook of Social Psychology," Clark University Press, pp. 426*ff.*, 1935.

SYNTHESIS OF ASCORBIC ACID IN EXCISED ROOTS OF THE WHITE MOONFLOWER

ASCORBIC acid is of very wide-spread occurrence in the roots of plants. The site of its synthesis constitutes a problem of considerable interest. Studies with intact plants are complicated by the possibility of transport from other organs. The answer to the question as to whether or not ascorbic acid is synthesized by the roots themselves can best be obtained by studies on excised roots.

Seeds of white moonflower (*Calonyction aculeatum*) were sterilized and germinated in darkness. When the radicles had attained a length of 2 to 4 cm the tips (1.5 cm long) were excised and transferred to flasks of nutrient solution. The composition of the nutrient solution was as follows: $Ca(NO_3)_2$ 0.0006 M; KNO_3 0.0008 M; $MgSO_4$ 0.00015 M; KCl 0.00087 M; $Fe_2(SO_4)_3$ 0.000006 M; $MnSO_4$ 0.000002 M; $Na_2B_4O_7$ 0.0000023 M; glucose 2 per cent. The cultures were kept at room temperature; one half of each set was exposed to diffuse daylight throughout the culture period, whereas the other was maintained continuously in darkness.[1]

Ascorbic acid determinations were made of samples of roots grown in the culture solution and of samples of seedling roots of the size and age of the original explants. The vitamin C content of the tissues was determined by a modification of the Tillmans method.[2] A combination of 8 per cent. metaphosphoric acid in 8 per cent. acetic acid was employed in extracting the juices.

Table I presents the results of three experiments involving 20 determinations on 132 cultures. Each value

TABLE I

ASCORBIC ACID CONTENT OF EXCISED MOONFLOWER ROOTS

C content of roots similar in age and size to original explants		Cultures in dark		Cultures in light		Culture period
mg/g fresh wt.	mg/root	mg/g fresh wt.	mg/root	mg/g fresh wt.	mg/root	(wks.)
0.135	0.0039	0.0263	0.0042	0.0638	0.0158	14
		0.0322	0.0038	0.1100	0.0398	8
		0.0292	0.0039	0.0984	0.0293	8

in the table represents an average of 2 to 4 tests. The data show that roots cultured in light contained approximately 4 to 10 times the quantity of ascorbic acid in the original explants, whereas those cultured in dark-

[1] Facilities for the culture work were very generously made available by the Botany Department of the George Washington University. A detailed account of the culture technic will be published separately in Smithsonian Institution Miscellaneous Publications.

[2] R. R. Musulin and C. G. King, *Jour. Biol. Chem.*, 116: 409–413, 1936.

ness show no significant difference. Previous studies[3] with cow peas have shown that roots of plants grown with their shoots in the light contain several times as much ascorbic acid as those of plants grown in darkness.

The excised moonflower roots cultured in the light possessed a deep green color due to the presence of well-developed chloroplasts. For this reason a strict comparison can not be made between these light-grown cultures and the colorless roots of intact plants grown in the light. The excised roots grown in darkness may be more nearly comparable to the roots of intact plants, since both lack chloroplasts.

It has been observed[4] in other experiments with intact plants that roots with a relatively low content of ascorbic acid during a prolonged period of cloudy weather showed a marked increase of this substance following a day of bright sunshine.

Although the evidence is not conclusive, it seems probable that the increased quantity of ascorbic acid in the excised roots cultured in the light is due to the presence of well-developed chloroplasts. If this is true, it seems probable that the colorless roots of intact plants grown in the light do not synthesize vitamin C but receive their supply from the tops. It is planned to continue these studies, using excised roots which do not develop chlorophyll.

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A NEW MENINGOTOXOID

FOLLOWING the successful production of a toxin from gonococcus as well as a potent antitoxin against the same,[1] it was considered of interest to ascertain if similar procedures followed out with meningococcus might not also yield equally promising results. This note is merely to record briefly the method followed and the results obtained to date and is preliminary to a report to be made later.

THE METHOD

Ordinary broth having a pH of 7.7 was used. Two per cent. dextrose was added and the media distributed in quantities of 400 cc to diphtheria toxin flasks. It was seeded with an indigenous strain of meningococcus (No. 64) by planting a pellicle on the surface of the media. The culture was incubated at 37° C for 12 to 15 days until the surface growth or pellicle began to settle to the bottom of the flask. The broth culture was then filtered through Zeiss paper filters K and EK and the filtrate used for the first experiments. This filtrate was found to be so toxic that finally 3 to 4 per cent. of formaldehyde was added to it and then it was incubated at 40° C for 45 days. The toxin was then precipitated by adding 1.5 per cent. alum, the precipitate duly washed and finally dissolved by adding 4 per cent. sodium citrate. The toxoid thus obtained was used for the next series of experiments.

RESULTS

The unmodified toxin when injected into mice intravenously in quantities of 0.2 cc killed immediately; 1.0 cc injected intravenously into guinea-pigs was also lethal at once. The intradermal injection into guinea-pigs of 0.2 cc caused necrosis. This filtrate was thus observed to be of high toxicity. It also gave flocculation and precipitation reactions when tested with anti-meningococcus serum. Its antigenic properties in animals were found to be of a high grade. Repeated injections led to the development of antibodies, as proved by flocculation tests.

The filtrate treated with formaldehyde and then precipitated with alum afforded a much more satisfactory toxoid. This toxoid was much less toxic but retained all its capacity to elicit antibody formation. For instance, one month after the injection of a single dose of 1.5 of the alum-precipitated toxoid into rabbits the presence of antibodies in their sera was demonstrated.

In humans it was shown that consecutive injections of 0.5 cc, 1.0 cc and 1.5 cc of the non-precipitated toxoid or of 1.0 cc of the precipitated toxoid caused the formation of demonstrable antibodies in their sera.

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INCREASED SENSITIVITY OF HYPOPHYSECTOMIZED RATS TO RADIATION

IN a study of the metabolism of Na and K in relation to adrenal cortical physiology, we have administered radioactive isotopes of these elements to variously treated animals. We have been surprised to find that hypophysectomized animals could not tolerate these "tagged atoms" even in "physiological" doses (*i.e.*, 10 microcuries), while intact animals and adrenalectomized animals show no untoward effects from such doses.

Our attention was first called to this phenomenon in an experiment in which 10 hypophysectomized rats received approximately 10 microcuries of radioactive K and four such animals an equivalent dose of radioactive Na made up in a 1 cc isotonic solution and injected intraperitoneally. All the animals were dead within 48 hours. In a large series of normal rats to which the same dose of these radioactive isotopes had been administered, no ill effects have been observed.

We next selected ten animals which had been hypo-

[3] Mary E. Reid, *Amer. Jour. Bot.*, 25: 701–711, 1938.
[4] Unpublished data.
[1] Gonococcus toxin and antitoxin, *Zentrabl. f. Bakt., Parisitenkun., u. Infektionskr.*, I Abt. Orig. 1939, Bd. 143.