predecessors with the orang have well pointed out, namely, the greater integration of localised representation of movements in the anthropoid as compared with the lower ape. Thus there is not one of the fingers that we have not seen move separately and alone under excitation of certain points of the cortex: again isolated movement of the pinna of the ear, of the tip of the tongue, rare in the lower monkeys are easily obtainable in the anthropoid.

Finally, one word with regard to the extent of the so-called motor area. From our observations we think it probable that perhaps as much of that area lies hidden from the surface in the sulci as actually lies at the free surface on the convolutions. Nevertheless, we endorse the opinion expressed by Beever and Horsley that the so-called motor area in the anthropoid brain forms altogether a smaller fraction of the total surface than is found in the lower types of monkey. If it has grown in extent—as undoubtedly it seems to have done—other regions belonging to that so-called inexcitable field whence electric stimulation excites no obvious response have increased still more. It is especially with the exploration of that great inexcitable field that the progress of research has to deal. We cannot help thinking that this progress will have to look for means to the patient combination of clinical and microscopical research rather than to the excitation experiments of the laboratory.

We would call your attention to the fact that the results on the gorilla confirm perfectly those we have obtained on the chimpanzee and orang. This is a matter of interest because many considerations go to show that the gorilla's brain is the highest form of brain excepting only that of man himself.

We have ventured to put before you only the broadest features of the results at present accumulated by us. The detailed collation of our observations may bring out points of interest of a more detailed kind, but the process of collation will be a matter occupying a good deal of time.

REFERENCES.

- ¹ *Functions of the Brain*. London, 1876. ² *Ibid.* ³ *Festschrift zu Karl Ludwig*. 1887. Leipzig.

ON THE QUANTITATIVE ESTIMATION OF CHLOROFORM IN ANIMAL TISSUES.

By A. D. WALLER, M.D., F.R.S.,

Lecturer on Physiology, St. Mary's Hospital Medical School, London.

Prefatory Note.—I have summarised in the following brief account the results of the quantitative estimations of chloroform carried on by Dr. Dodgson in the physiological laboratory of St. Mary's Hospital Medical School during the years 1898 and 1899 at my suggestion and by aid of a grant from the British Medical Association. Dr. Dodgson's work and the preparation of his report were interrupted by his appointment to investigate the results of antityphoid inoculation in South Africa. His absence having become unexpectedly prolonged, and the work begun by him having passed into other hands by reason of the appointment in July last of a special Chloroform Committee by the Council of the British Medical Association, I have at Dr. Dodgson's desire prepared the following summary of his laboratory notes. The credit for work done is Dr. Dodgson's. The responsibility for the summary is mine, and I trust that any defect of this summary will at some future time be made good by a fuller account of the subject from Dr. Dodgson's pen.

SUMMARY OF DR. DODGSON'S OBSERVATIONS.

The methods of quantitative estimation hitherto employed are in chronological order:

1. That of Lallemand, Perrin, and Duroy, 1850.
2. That of Schmiedeberg, 1867 (modified under his direction by Pohl, 1891).
3. That of Gréhan and Quinquaut, 1883.
4. That of Chancel and Farmentier, 1885.

In principle the method of the French observers consists in the decomposition of chloroform by a strong solution of

potash and subsequent volumetric estimation of chlorine the resultant potassium chloride.

This procedure is directly applicable to an aqueous solution of chloroform, and can be applied to a mixture of chloroform and air, the gas being first brought into aqueous solution by shaking with a sufficient volume of chloride-free water. In the case of blood and tissues, the chloroform present is first distilled off *in vacuo* and a chloride estimation made as before in the distillate. Gréhan estimated chloroform in the distillate by the reducing power upon Fehling's solution.

In the German method of estimation the chloroform present in a fluid or tissue is distilled off and slowly aspirated through a combustion tube filled with calcium or preferably magnesium oxide, and the resultant chloride estimated as before by AgNO_3 . This method is also applicable to the quantitative estimation of chloroform in air, a known volume of the gaseous mixture being slowly driven through the combustion tube by mercury displacement.

After trial of all these various methods with known weights of chloroform in water, in blood, and in small animals, the following procedure was adopted as giving the most trustworthy results as regards the quantitation of chloroform in small animals and organs of large animals.

[The results of preliminary trials by the potash method need not be given in detail. These results were less promising of accuracy than the preliminary results of combustion, which therefore was adopted as the standard method. It is possible, however, that on further trial the method by digestion with strong KOH may prove to be an available one. The experiments reported by Dr. Edmunds in the *Lancet* point in this direction.]

In the early trials of this method made by Dr. Dodgson the deficit per 100 in 5 successive experiments was with the distillate 13, 12, 20, 23, 15, and in 2 experiments with the original solution (1 c.cm. of CHCl_3 in 999 c.cm. of water)—20 and 21. The only remarkable point in these results is that the error was about the same (20 per cent.) for 100 c.cm. of the original fluid, as for the distillate of 100 c.cm.—that is, that as much CHCl_3 is recoverable from the distillate of an aqueous solution as from the original solution.]

APPARATUS AND METHOD (SEE FIG. 1, p. 1860).

A.—Distillation and Combustion.

A is a glass vessel with two-way Drechsel stopper to contain the distilland (water, blood, organ, or small animal) and placed in a water bath. The inlet and outlet tubes are connected respectively with w b (a wash bottle) and f c (a froth chamber). The volatile products of distillation are slowly drawn through a combustion tube (b b) by means of the aspirator (c). The combustion tube (b b), 80 cm. long and 14 mm. in diameter, is filled with granulated MgO (previously washed until chloride free), and kept at red heat in an ordinary gas furnace. Two wash bottles containing respectively KOH and AgNO_3 , placed between combustion tube and aspirator, serve to stop and to indicate any possible escape of HCl through the combustion tube. No such escape occurred, however; the rate of aspiration was maintained at about 60 bubbles per minute.

Estimations were also made without heat in the cases of chloroform in water and chloroform in blood—in the latter case for the sake of avoiding coagulation of proteids—air being slowly aspirated through the solution at ordinary temperature. In this case a longer duration of experiment was necessary than when heat was employed. The two ends of the combustion tube were bent at a right angle, and connected with the other parts of apparatus by mercury joints m. m. at the two ends.

The duration of a distillation was generally four to six hours (*vide tables*), at the end of which time the chloride present in the combustion tube was titrated, and from this result the amount of CHCl_3 in the distilland calculated.

B.—The Estimation of Chloride.

This was conducted as follows:—The combustion tube when cooled was turned up and filled with 30 per cent. HNO_3 . The solution when complete is transferred to a beaker; the tube is washed out with a known volume of distilled water. The titration of chloride is carried out with AgNO_3 and AmSCN with iron alum as the indicator (Volhard's process).

Fig. 1.—Apparatus.

By preliminary trial the error of this stage of the process was determined to be ± 0.0001 gram Cl.

The results so far obtained by this method are summarised in the following tables, giving the quantities recovered of (approximately) known quantities of CHCl_3 mixed (1) with water and with blood, (2) inserted into the peritoneal cavity of recently killed rats, and (3) the quantities recovered from

animals killed by the inhalation of unknown quantities of CHCl_3 .

It is evident that much remains to be done before we may hope to obtain definite quantitative information as regards the distribution of chloroform in the fluids and tissues of animals chloroformed to a surgical degree and chloroformed to death.

TABLE I.—Amounts of Chloroform Found in Mixtures of Measured Volumes of Chloroform in Water, in Blood, and in Serum, Calculated from Chloride Found in Combustion Tube. Aspiration made without Application of Heat.

	Duration.	Contents of Vessel A.	Weight of CHCl_3 Taken.	Weight of CHCl_3 Found.	Difference.	Error per 100.	Remarks.
Experiment 1	$6\frac{1}{2}$ hours	100 c.cm. water + 0.1 c.cm. CHCl_3	0.150 gram	0.134 gram	-0.016	-11	
" 2	16 "	200 " " + 0.2 " "	0.300 "	0.316 "	+0.016	+5	
" 3	$6\frac{1}{2}$ "	100 " " + 0.2 " "	0.300 "	0.308 "	+0.008	+3	
" 4	4 "	100 " " + 0.2 " "	0.300 "	0.290 "	-0.010	-3	
" 5	4 "	400 c.cm. blood + 0.2 " "	0.300 "	0.216 "	-0.084	-28	Short period of aspiration; chloroform is disengaged more readily from water than from blood.
" 6	1 "	100 " " + 0.2 " "	0.300 "	0.177 "	-0.123	-41	Ditto ditto.
" 7	18 "	200 " " + 0.3 " "	0.450 "	0.449 "	-0.001	-0.2	Long period of aspiration.
" 8	18 "	200 " " + 0.3 " "	0.450 "	0.460 "	+0.010	+2	Long period of aspiration. The source of the + error in this series was discovered and removed at Experiment 19 of the second series.
" 9	4 "	200 " serum + 0.3 " "	0.450 "	0.417 "	-0.033	-7	

TABLE II.—Amounts of Chloroform (Calculated from Chloride) found by Distilling Small Animals into which Weighed Amounts of CHCl_3 had been introduced. The Animals (Rats) weighed approximately 200 grams, and the Chloroform was introduced by weighed Glass Bulbs.

	Duration.	Weight of CHCl_3 introduced.	Weight of CHCl_3 found.	Difference.	Error per 100.	Remarks.
Experiment 10	$4\frac{1}{2}$ hours	0.324 gram	0.262 gram	-0.062 gram	19	Some CHCl_3 lost by exposure to air.
" 11	5 "	0.277 "	0.275 "	-0.002 "	1	
" 12	5 "	0.397 "	0.308 "	-0.081 "	20	Mishap during analysis for chlorides.
" 13	$4\frac{1}{2}$ "	0.128 "	0.127 "	-0.001 "	1	
" 14	$4\frac{1}{2}$ "	0.238 "	0.234 "	-0.004 "	2	
" 15	5 "	0.000 "	0.000 "	0.000 "	—	Check experiment without CHCl_3 .
" 16	$4\frac{1}{2}$ "	0.158 "	0.152 "	-0.006 "	4	
" 17	$\left\{ \begin{array}{l} 4 \\ 4 \end{array} \right\}$ "	0.487 "	$\left\{ \begin{array}{l} 0.481 \\ 0.004 \end{array} \right\}$ "	$\left\{ \begin{array}{l} -0.006 \\ 0.004 \end{array} \right\}$ "	$\left\{ \begin{array}{l} 1 \\ 1 \end{array} \right\}$	Second distillation of same animal.
" 18	5 "	0.016 "	0.019 "	+0.003 "		
" 19	$4\frac{1}{2}$ "	0.000 "	0.003 "	+0.003 "		Check experiment; source of error traced.
" 20	$4\frac{1}{2}$ "	0.000 "	0.000 "	0.000 "	—	Check experiment; error abolished.

TABLE III.—Amounts of Chloroform (calculated from Chloride) found by Distillation of Small Animals (Rats) Killed by Inhalation of Chloroform Vapour.

	Duration.	Weight of Animal.	Weight of CHCl ₃ Found.	Lethal Quotient, Ratio of CHCl ₃ to Body Weight.	Remarks
Experiment 21 ...	6½ hours	175 grams	0.0164 gram	0.000094	
" 22 ...	6 " "	191 " "	{ 0.0180 " "	{ 0.000102	First distillation.
" 23 ...	{ 7 " "	" "	{ 0.0015 " "	{ —	Second distillation of same animal.
" 24 ...	{ 15½ " "	157 " "	{ 0.0000 " "	{ —	Check experiment; no CHCl ₃ introduced.
" 25 ...	{ 15 " "	" "	{ 0.0000 " "	{ —	Same result on second distillation.
" 26 ...	{ 17½ " "	168 " "	{ 0.0157 " "	{ 0.000093	First distillation.
" 27 ...	{ 16 " "	" "	{ 0.0000 " "	{ —	Second distillation of same animal.
" 28 ...	16½ " "	174 " "	0.0170 " "	0.000098	
" 29 ...	22 " "	210 " "	0.0250 " "	0.000119	

The mean lethal quotient of 5 experiments is 0.000101, or very nearly 1 part of chloroform by weight to 10000 parts of animal by weight.

The results recorded in the preceding summary are defective mainly as regards Table I, which should contain a more extensive and accurate elementary justification of the method. The data of this table were, however, obtained at the outset of the investigation, when experimental error was great. Table II is more satisfactory, the experimental error is greatly diminished; and in those instances where an unduly large deficit has occurred, the source of error has been clearly due to some very recognisable and therefore avoidable accident. These "bad" results might properly have been omitted from the summary, but have been left undisturbed on account of the warnings they convey. Table III, containing the latest series of experiments, in which various improvements of detail suggested by previous experiments had been introduced, is probably the most accurate, although obviously there is here no measure of inaccuracy possible by comparison between amount of CHCl₃ taken and amount found.

The preliminary conclusion from this last series—to be confirmed or modified by further experiment—is that the weight of chloroform recoverable from the body of a small animal killed by the inhalation of chloroform amounts to 1 part in 10,000 of the body weight in the case of a small animal (rat), a quotient which is about twice that estimated by Snow as being lethal to the human subject.

THEORIES OF INHERITANCE.

By G. ARCHDALL REID, M.B., F.R.S.E.,
Southsea.

ALL the characters of a living being may be grouped under one or other of two headings—either they are *inborn* or else they are *acquired*. Inborn characters may be defined as those which take origin in the germ cell. Thus arms, legs, eyes, ears, etc., are all inborn. They arise because the germ cell is so constituted that it tends under fit conditions of shelter and nutrition to proliferate into an organism having arms, legs, eyes, ears, etc. An acquired character (technically termed "modification") is an alteration impressed on an inborn character by influences acting on that character *after* it has developed from the germ. Thus a hand is inborn, but if it be altered in any way, as by use or injury, the alteration is an acquirement. It will thus be seen that the difference between the inborn and the acquired is essentially one of *origin*. Inborn traits take origin in the germ, acquired characters in cell descendants of the germ. It is necessary to dwell on this point. Endless confusion has arisen through the ambiguous use of the term "acquired." For instance, in medical literature, the term is frequently used as synonymous with "new," and every new character is then called an acquirement. Thus a sixth digit on its first appearance in a family is often called one; but a sixth digit, since it results from a germinal peculiarity, is no more an acquirement than a man's head is. It could only be an acquirement were it implanted on an already developing hand by outside influences.

VARIATIONS.

Among the higher animals at least offspring invariably differ inherently from their parents—that is, they are born different from what their parents were born.¹ They make a

¹ I use the word born to avoid circumlocution. But of course if an embryo or fetus (as distinguished from a germ) acquired a character (say a disease), the change is as much an acquirement as if acquired after birth.

different start in life. These congenital differences are technically termed "*variations*." Thus a sixth digit on its first appearance in a family is a variation. It follows, since a variation takes origin in the germ, that it is not an acquirement, but an inborn trait. It arises because the germ from which the offspring sprang is different from the germ whence the parent sprang. Formerly the term "variation" was used in a less restricted sense, being applied to acquirements, as well as to congenital differences. But in the interests of scientific precision of late years the more restricted meaning has generally been adopted.

ALLEGED TRANSMISSION OF ACQUIREMENTS.

It is a fundamental assumption of every theory of heredity that variations (not acquirements) are transmissible to offspring, and through them to remoter descendants. Thus a sixth digit after its first appearance tends to be transmitted to posterity. The fact is nowhere disputed; and up to this point all theories of heredity march together. But they differ in the causes they assign to variations; that is, in the reason by which they seek to explain the fact that children at birth differ from their parents at birth. At present we need not enter into an elaborate exposition of the many theories that have been formulated in past times to account for variations. It will be sufficient if we note the theory which finds most favour among medical men and the rest of the general public. This theory, authentically as old as the patriarch Jacob, is certainly of even vaster antiquity. Probably it dates from the time when men first began to consider the relation of child to parent; that is, from the time when men began to reason. According to it, parental acquirements (that is, changes in the parental soma) tend so to affect the associated germs that identical variations are reproduced in the offspring which spring from the germs. Thus it supposes that, if a man strengthens his arms by exercise, his germs will be so affected that his offspring will tend to have arms stronger than they would otherwise have had. In that case the child is born different from what the parent was born, since it has inborn the peculiarity the parent only acquired. According to this—the Lamarckian—theory, then, the parents' acquirements tend to be transmuted into variations in the child, and thus to become transmissible to the child's offspring and to remoter descendants. It is, in fact, the theory that supposes that parental requirements are transmissible.

Before we proceed to test the truth of this alleged transmission of acquired characters it is necessary to note one fact of vital importance. Even if it be true that acquirements are transmissible, yet it is abundantly clear that variations in offspring cannot all be attributed to the transmission of parental acquirements. Thus, since no man ever acquires a sixth digit, since a sixth digit is always inborn from the first, that structure on its appearance in an infant can never be attributed to the transmission of an acquirement. Again, the individuals of a litter of puppies not only vary from their parents but they differ among themselves. Some of them are bigger or stronger, smoother or rougher than the others. The endless differences cannot be attributed to the transmission of parental acquirements, for the acquirements if transmitted would produce the same variations in all the puppies. Clearly, then, variations do arise in offspring quite irrespective of the transmission of acquirements. How they arise