difference—that, inasmuch as the work done is internal to the organism, there is no perception and no knowledge of the order of events, such as is attained when a man energises to attain an end he desires by the use of his limbs, and can see or perceive that it is attained. Knowing he has a heart, he may, however, by frequent effort, influence its motions volitionally, and may even contract and relax his iris at will. The great trophic centre by and through which the hemispheres thus act in emotions and volitions is probably, according to my researches, the cerebellum. If this be out of gear, as in emotional dreaming all the willing a man may make in his dream-fear and terror will not help him to move a limb or to utter more than a feeble wail.

(To be continued.)

Observations on the Brain of the Chacma Baboon. By HERBERT C. MAJOR, M.D., Edin., West Riding Asylum, Wakefield.

An opportunity having been afforded me, through the kindness of Mr. A. H. Garrod, of examining the brain of a fine specimen of the Chacma Baboon (cynocephalus porcarius) from the Zoological Society's Gardens, London, I purpose, in the following pages, to record, so far as I may be able, the minute structure of the convolutions in the various parts of the cerebral hemispheres. It will be my endeavour in this inquiry to study the nerve elements of the cortex step by step, and layer by layer, and thus gradually to unfold its structure; to analyse and compare the varying appearances in different situations; and finally, collecting and arranging the facts thus elicited, to place them side by side with those derived from a study of corresponding parts in the human organ, and ascertain, if possible, the relations which exist between them.

One of the largest and most powerful of the baboons, the Chacma, while considerably lower in rank, and having a brain less highly developed as regards its general characters than that of the Orang, Gorilla or Chimpanzee, claims fairly, nevertheless, a place among the higher apes. In it, as compared with the Chimpanzee, the convolutions of the hemispheres are generally less numerous and complex and there is less development of the frontal lobes; and, on the other hand, there is a corresponding increase in the size of the occipitals. The bridg-

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ing or annectent gyri, which are conspicuous in man, and which are also to be found to a certain extent in the Orang, are here absent, and the temporo-sphenoidal lobes are less horizontal and more depressed than in the Orang or Chimpanzee.*

Such, then, briefly are among the most important external characters which have been described as separating the brain of the baboon from that of its more exalted brethren. It is to me a source of much regret that in the present instance I am not able to give an accurate description of the external conformation of the brain, the number and course of the convolutions, and the relative weights of the various lobes—facts which would have added greatly to the completeness and value of my observations. For the most part, this omission has been due to the fact that it is difficult to combine in any single case an accurate and exhaustive study of the general anatomical characters of the brain, without at the same time damaging the organ, and rendering it unfit or unreliable for histological study. Of course, where several specimens are forthcoming, the requisite facts may be readily gathered; but where, as in the present instance, specimens are rare, the difficulty is as I have stated. At present, therefore, I take up the question of histological structure, leaving on one side, but in no way unmindful of, the importance of the questions of weight, development, and convolutionary arrangement of the organ. For in the study of the organ of the mind, and the relation which it bears to individual intelligence, I hold that *quality* deserves the highest place, and second only to it is *quantity*.

Before entering more closely on my subject, a few remarks may not be out of place, with a view of showing the nature and extent of previous investigations in this department of comparative anatomy. The general conformation of the brain in apes, and the arrangement of the convolutions, have been described by Owen, Huxley, Turner, Gratiolet, Meynert, Marshall, and others, names which in themselves are evidence of careful and accurate investigation. Far otherwise is it, however, with the study of the minute anatomy of the nerve elements which enter into the formation of the cortical substance, and the relation which they bear to the corresponding structures in the human organ. A few facts are to be found in the article by Th. Meynert (Stricker's Human and Comparative Histology); but these, valuable as they are as

* "Man and Apes," by St. George Mivart, F.R.S., p. 138, *et seq.*

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coming from one of our very best authorities, are still very limited, and do not reach what is wanted, viz., a thorough description of the cortical structure in apes, similar to that which Meynert has been so greatly instrumental in affording in the human subject. I find that Dr. Lockhart Clarke makes the observation that, while recognising with certainty differences between the cells of the convolutions in man and those of some of the larger mammalia, as the ox, sheep, or cat, he could perceive no difference whatever in the case of the ape tribe.* In his work before alluded to, St. George Mivart argues on the presumption that there are no histological differences between the nerve elements in man and in the higher apes, from the fact that none have been shown to exist, and states the difference to be one of actual mass, "a mere difference of degree and not of kind."† My own work in this direction has till now been limited to the brain in the smaller apes, a study of the cortex in which formed the subject of a graduation Thesis presented to the University of Edinburgh. I may be permitted later on to refer to some of the results I there recorded; but I may say here that, so far as I have been able to ascertain, this essay was the first record of systematic comparison (though, of course, limited in extent) between the nerve elements of the cortex in man as compared with the ape, and, together with the observations before alluded to, forms, I believe, at the present time, the only literature of the subject in this or any other country.

Our position, therefore, is this: that while recognising external differences which distinguish in the most certain manner such brains as that of the Orang or Chimpanzee from that of man, we are as yet baffled in our efforts to penetrate further. We know that the human cerebrum is supreme in size and weight both absolutely and relatively. It has been shown that the proportion which the hemispheres bears to the entire brain mass is greater in man than in the baboon, being about 78 per cent. in the former case, and 70·8 per cent. in the latter;‡ and we know, lastly, that it is by far the richest in the number and complexity of the convolutions, *i.e.*, in the extent of cortical substance. Must it, then, be accepted as a fact that there are no histological differences between them corresponding with the above coarse and universally acknowledged variations? To

* Maudsley's "Physiology and Pathology of Mind," 2nd ed., p 63.
† Loco cit., p. 149.
‡ Stricker's Hum. and Comp. Histology, p. 421.

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me it appears that all analogy and numerous facts combine to render such a condition in the highest degree improbable. The observations of Beale,* Clarke,† Meynert,‡ and Van der Kolk show that in such animals as the sheep, cat, dog, and rabbit, the nerve cells of the cortex differ very decidedly from those in man, and my own experience is quite in accordance with theirs. In some of the apes, again (I believe the smaller ones) Meynert has observed a peculiarity in some of the nerve cells in the occipital region, as compared with the structure in the human brain, to which I shall have occasion to refer later. Lastly, in my own researches before alluded to, which were for the most part directed to a description of the cortex in the occipital regions in the *smaller apes*, notwithstanding great general resemblance of structure to that in man, I was able to show by actual measurement that the size of the nerve corpuscles was less than in the human subject.

With such facts before us, it must seem, I should think, in the highest degree probable, that in the highest of the ape family certain variations from the human structure should still be present—differences, it may be, so slight as to be nearly unappreciable, but still differences of the widest significance and importance. It may be said that all analogy and *à priori* arguments must give way if opposed to actual observation and experience; but in reply to this, the arguments of Huxley appear to me conclusive. There is a limit to our powers of observation. Great as is the perfection attained by modern instruments, there may be points too delicate for their solution. And yet it is certain that in such minute differences, just as in trifling imperfections in delicate pieces of mechanism, may rest the answer to the great question at issue. To what does the human brain owe it ssuperiority as the organ of mind, as compared with that of the ape? Is it merely that its mass is greater, and that, as a consequence, the nerve elements which we know to be connected with the manifestation of intellectual processes are more numerous, while similar in other respects? Or, is there something more than this—something in the *structure* of the nerve elements, in their size, their connections, or in their chemical composition, which renders them fit to sustain the highest functions in the

* Proceed. Roy. Soc., June, 1863.
† Proceed. Roy. Soc., Sept., 1863.
‡ Stricker's Hum. and Comp. Histology.

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human economy, or adapts them for the mean capacity of a Baboon or a Chimpanzee ?

In comparing the structure of the brain of the Chacma with that of the human organ, it will be my endeavour to lay aside all theory and preconceived ideas, and to trace, with the greatest care, step by step, and layer by layer, the corresponding nerve elements in both. The parts of the brain selected for comparison will comprise, generally, the convolutions forming the vault of the hemispheres, and more especially the ascending frontal and parietal convolutions and the tips of the occipital lobes, as being the parts the structure of which is most familiar to me in the human organ, and, therefore, best adapted for purposes of comparative study. In the comparative histology of the cortex of the brain, the minute structure of which is liable to infinitely numerous, though slight, variations, even at points situated close to each other, it is very necessary to have certain definite landmarks, so to speak, if we would avoid hopeless confusion and erroneous conclusions.

The method adopted for the display of the brain tissue has been the same throughout the course of the investigation, and is that so well known as Clarke's method. The portions of brain were first hardened in chromic acid, or Müller's fluid, and thin sections made in different directions. The sections were then stained with logwood or carmine, dehydrated in alcohol, rendered transparent by oil of cloves, and finally mounted in Canada balsam. Notwithstanding some serious disadvantages of this system, due for the most part to the too great transparency of the tissue which it induces, the view of the nerve cells which it affords is very complete, more so, in my experience, than by any other method, and hence its great utility in the present inquiry.

The sections of human brain on which I have relied as standards of comparison were obtained from two presumably healthy young men, in both of whom death was the result of accident. The contrast presented by these two brains, as compared with cases where death has been slow and lingering, is very striking, and furnishes abundant evidence of this most important fact, demonstrated first, I believe, by Dr. Batty Tuke, of Edinburgh.

It would be too great an encroachment on valuable space, as well as unnecessary, to give the *complete* record which is now before me of the structure presented by the cortex of the brain of the Chacma. In many respects such structure,

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so far as could be made out by careful and prolonged investigation, is identical with that present in the human organ, and to enter on a full description under such circumstances would only be to reproduce, more or less closely, what has been said by others with respect to the human brain. While, therefore, it will be necessary for me to survey the various cortical layers in the Chacma, the description in many instances will be very brief, my object being to limit discussion by confining myself, chiefly, to points in which differences appear to exist. Under the following heads, it will be my endeavour to carry out the comparison, and it is hoped that the simplicity I shall endeavour to secure may enable the description to be followed by others besides the practised histologist.

I shall consider in the baboon, as compared with the human structure—

I.—The number and general appearance of the cortical layers.

II.—The general characters of the nerve, and other constituent elements of the strata. The latter will include a consideration of—

1st. The intimate nature and structure of the nerve cells.

2nd. The size of the corpuscles.

3rd. The number of the cell processes, and the nature and extent of the connections.

III.—The vessels and the white medullary substance.

I.—Now, with regard to the first of these points, viz.: The number and appearance presented by the cortical strata, I wish to state at once, and very decidedly:—1st, that the number in the Chacma corresponds exactly with that in man, in the frontal and parietal, as well as in the occipital lobes; 2ndly, that, not only are the general features and appearances of the layers, as seen with a low power, closely similar in both cases, but even the modifications of structure, which in man are found in the occipital regions, as compared with other parts situated more anterior, are equally plainly discernible, and give rise to similar appearances in the Chacma. It need scarcely be said that this is a most important fact to start with, one which must have some deep import, and which ought to be kept well in view. To the practised observer, the cells of the cortex are not a confused mass of bodies, but the layers which they form have definite characters, by which any one of such layers, even if isolated, may be distinguished with almost unerring certainty; and, still

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more, may often be referred to the portion of the hemisphere in which it was situated. Not without a wise purpose are the cells and strata thus differentiated and arranged; but whatever the significance of the fact, it is one which exists in the ape equally with man, while in both its import is at present quite inscrutable.

II.—I now pass to the second point selected for consideration, viz.: the general characters of the nerve elements in the various strata. This will involve, to a certain extent at least, a reference to each layer in detail; but the description may be greatly condensed, and still, it is hoped, be readily followed, by a reference to the accompanying plates, which represent, in the Chacma baboon, portions of the various layers in succession with their prominent peculiarities of structure.

The appearance presented by the corpuscles situated in the *first layer* of the cortex are represented in Fig. 1, which also shows the relation of the pia-mater in immediate contact with the upper surface of the stratum. It will be seen that the corpuscles, which are few in number, present three varieties. There are, in the first place, some which are round or oval in form and containing three small granules, but are destitute of branches. Others of the corpuscles, again, have two or three branches, which present distinct anastomoses with similar bodies situated in the pia-mater, while, also, those in the latter membrane send down branching processes, some of which join other cells, while others become lost in the general matrix of the layer; and, thirdly, there will be noticed a corpuscle the peculiarity of which consists in its large number of thread-like processes. This is one of the so-called connective tissue corpuscles of Deiter. While of rare occurrence in this situation, there can be no doubt of the presence of these bodies, and of the almost numberless connections which they have with each other, as well as with the vessels. Now, all the corpuscles of the layer may, I believe, be referred to one or other of the groups above described, and all, I think, belong to the *connective tissue* system. The *intercellular matrix* of the layer (which in this instance has not been delineated with the object of rendering the connections actually traced between the cells the more distinct) is made up of a meshwork of minute fibrils which are largely derived from the corpuscles above described and a fine, almost homogeneous, substance which everywhere pervades the cortex, and which, by some, has been attributed to post-mortem changes. Finally, nerve fibrils pass in all directions, in their passage upwards from

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the cells beneath. I may in this place remark, in passing, that the connections above described and figured as existing between the pia-mater and the brain substance, and which are similar in man, have not, I think, been generally recognised, and, as it appears to me, may probably play an important part in the formation of *adhesion* of the pia-mater which takes place under certain morbid conditions.

The closely arranged and small cells constituting the *second cortical layer* in the frontal and parietal regions, are represented in Fig. 2. In size, they average about $\frac{3}{250}$ *millimetre* in length, and are distinctly pyramidal in form. They give off processes which run in various directions, the one from the apex being directed outwards, while those from the base pass horizontally, or backwards. The upper surface of this layer is well defined, but inferiorly it passes somewhat gradually into the succeeding stratum.*

The third layer in the frontal and parietal lobes is the broadest of all, and contains the largest cells in greatest number. The majority average from $\frac{3}{250}$ to $\frac{4}{250}$ *millimetre*, but a few, as will be stated later, are much larger. Their general form is very distinctly pyramidal. The apex process is directed outwards, those from the basal angles pass more or less horizontally, while from the centre of the base there runs, almost invariably, a very distinct process directly backwards. The general characters above described are represented in Fig. 3, where also are shown the clear spaces surrounding the nerve cells, and which have been considered by Obersteiner as lymphatic spaces. But while the above forms of nerve-cell is most common, others may be seen not only of larger size but different in character and appearance. In them the nucleus is of very large size, round or oval in form, faintly stained by the colouring fluid, and contains several granules. The surrounding protoplasm is hazy and ill-defined in appearance, usually oval in form, and the branches are few in number and indistinct. These bodies will be again alluded to in connection with other layers in which their number is greater than in the third, but wherever seen, their peculiar characters enable them to be recognised at once, so different are they from the others. In the deepest part of the third layer, just before it passes into the fourth, are seen, at intervals, pyramidal cells of very large size (Fig. 5), some measuring as much as $\frac{10}{250}$ *millimetre* long by $\frac{6}{250}$ *millimetre* broad. These are rare, however, as compared with the others, and it is noteworthy that their branches

* Compare Meynert, *loco cit.* p. 234.

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are not numerous. Smaller nerve cells and neuroglia corpuscles complete the cell element of the third layer, and all are imbedded in the general connecting framework or neuroglia.

In the *occipital* lobes there is a very distinct and highly characteristic variation from that above described, with regard to the second and third layers. Here the distinction between the outermost nerve-cells and those situated deeper, is not sufficient to constitute distinct layers, but they form a rather broad band of pyramidal bodies, varying little in size, and having an average length of about $\frac{2}{250}$ *millimetre.* It is to be observed, however, that in this region the large hazy corpuscles are found more abundantly than in the corresponding layers of the other lobes, while their size does not diminish, as is the case with the deeply stained pyramidal bodies.*

Succeeding the above, comes the *third cortical layer* of the occipital region—a layer which, in its position, corresponds with the deepest portion of the *second* layer in the other lobes, but from which it differs very decidedly. It extends in the form of a pale and somewhat narrow band, parallel with and immediately preceding the dark fourth layer. Its cells, it will be observed (Figs. 6,7) are few in number, the most prominent being the pale, large-nucleated variety, while the well-defined pyramidal bodies are both small and few in number. It is for this reason that the region is pale, and contrasts strongly with the strata situate on either side of it. It will thus be seen that, whereas in the frontal and parietal regions the second and third strata are both made up of pyramidal bodies the distinction between them being due to the variation in size and number, in the occipital region the pyramidal bodies form one layer, the *second*, and following this is the pale third stratum last described. Thus, to put the relation in a tabular form :—

	Frontal and Parietal.	Occipital.
1st layer.	Same in both.	
2nd layer.	Small pyramidals (narrow band).	Small pyramidals (broad band).
3rd layer.	Large pyramidals (broad band).	Large pale bodies (narrow band).
4th layer.	Same in both.	

If the above arrangement is understood, then the great distinction between the arrangement of the layers in the occipital region, as compared with the others, has been mastered.

The fourth layer (fig. 8), the most distinct and character-

* Meynert, *loco cit.*, p. 391.

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istic of all, varies but very slightly in the different regions of the brain, and with the aid of the plate, its description may be summed up in a few words. The cells composing it are of small size, and remarkably regular in appearance. For the most part pyramidal in shape, they are closely arranged in the form of vertical rows or bands, between which run in the most regular manner bundles of fibrils in their passage downward from the layers above. In size the corpuscles average from $\frac{1}{250}$ to $\frac{2}{250}$ *millimetre*, but are slightly smaller in the occipital region than in other parts, while on the other hand, in the occipital lobes, the vertical bands which they form are closer, and the bundles of fibres more compact than in the frontal and parietal regions. Occasionally, as is seen in the drawing, the larger pale corpuscles are found, but in this layer their presence is quite exceptional.

The fifth layer (Fig. 9) contrasts very strongly with the preceding, both in general appearance and in the character of the corpuscles which enter into its formations. The latter are usually of the pyramidal type, but are of small size, and hence the pale appearance which the layer presents. In this situation, however, more frequently perhaps than in any other, very large nerve cells are found. Usually, these have the characters of the large nucleated, pale bodies, already frequently referred to, but they sometimes resemble closely the large pyramidal cells before described in connection with the *third* stratum in the anterior portions of the hemispheres. Their number, however, is not considerable. Some distinction must be drawn with regard to the characters of the cells of this layer in the occipital region as compared with the anterior lobes. In the occipital region, the fifth layer (as is the case with nearly all the others) is most sharply defined, and very closely resembles the *third* stratum in the same regions. I find, also, that the pyramidal cells are rather smaller, while the large, faintly-stained bodies are more numerous than in the corresponding layer in the anterior parts of the hemispheres.

The sixth layer (Fig. 10) remains to be described; and while its general characters, in all the lobes, agree pretty closely, yet in different parts of the same convolution it is subject to regular and decided modifications, which must be described. If the layer be examined as it runs up the side of a convolution, the cells, almost without exception, will be found to be closely arranged, of pyramidal, though somewhat stunted form, and deeply stained by the colouring fluid, while the

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direction of their apices is very regularly *outwards*, *i.e.*, at right angles to the plane of the stratum. But if the layer be traced to where it turns round at the bottom of a sulcus, the cells are seen to be somewhat spindle-shaped, and are no longer vertical, but horizontal, or, as I am in the habit of describing the position, *reclining*. It is owing to this change in the direction of the long axis of the cells, which thus take up less *vertical* space, that at the bottom of the sulci, the diameter of the layer is very decidedly diminished. And finally, in that part of the layer which corresponds to the superior free surface of the convolution, the cells are drawn out in the form of long spindle-shaped bodies, running parallel, which, in consequence of their *vertical* direction, considerably increase the thickness of the stratum, and give rise to an appearance found nowhere else throughout the cortex (Fig. 10). To repeat—at the bottom of the sulci the cells are horizontal, somewhat spindle-shaped, and the layer which they form is at its narrowest. Running up the side of the convolution, the cells are vertical (*quoad* the plain of the stratum) pyramidal, and the layer is thicker. Lastly, passing round the superior aspect of the convolution, they are drawn out in the form of long vertical spindles, and the layer is at its thickest.

It is a difficult and uncertain matter to venture on an estimate of the size of the corpuscles in this layer, it being, as I have shown, so variable, but they are certainly larger and more numerous than in the preceding stratum, are of a deep colour, from the presence of pigment, and are deeply stained by the colouring fluid.

With regard to the structure of the *neuroglia*, little remains to be said. I have already described it as consisting of a delicate meshwork, made up of the finest processes of nerve and other corpuscles, and a delicate homogeneous matrix. In this state it extends throughout the cortex, supporting the cells and vessels. It also contains pale nuclear bodies, like those already described and figured in connection with the first layer, and which are known as the corpuscles of the neuroglia.

Turning now to the question, whether, in the various cortical strata of the human brain, the *general characters* and appearance of the cell-element agree with those above given, as present in the Chacma baboon, the answer must be a decided affirmative. Let any layer in cortex of the Chacma's brain be chosen, the characters I have given of the nerve-elements

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composing it would enable the corresponding stratum in the human organ to be selected. Thus, a second great fact has been arrived at; viz., that in the brain of the Chacma and in man the general character and appearance, *i.e.* form and relative number, of the cell-element in the various layers, show no variation.

The object of search, if to be found at all, must evidently be sought deeper.

1.—With the highest powers at my disposal, I have failed to detect any difference in the intimate construction of the nerve cells in the baboon, as compared with that in man. In both cases the nucleus, the nucleolus, and the mass of protaplasm forming the body of the corpuscle appear to me to be alike in their nature, as they are, also, in appearance. At present, however, I cannot venture on more than this guarded statement, not having used a higher objective than the one-tenth Hartnack.

There is a point, however, with regard to some of the cells in the Chacma which must not be passed over, and which, indeed, might well have been stated sooner. While the fact remains true that in the various layers of the cortex in man and in the baboon the general characters of the cell elements agree, it is nevertheless also true that, in the present case that form of cell frequently described and figured as pale in colour, hazy in outline, and having large nuclei, is more common in the baboon than in man. But while this is the case, I cannot, without further experience, venture to lay it down as a point of general distinction. Nerve cells in the course of their development and growth undergo changes, and it may be that the condition is accidental; for, as before stated, the form of nerve cell in question is not by any means absent in man. Nevertheless, it is possible that the point is one of much importance, although at present it is very obscure; and, at any rate, it is worthy of close attention and further observation.

2.—There is, perhaps, nothing in comparative histology of the brain more difficult to arrive at than an accurate estimate of the size of the various corpuscles. It cannot, indeed, be otherwise, when the vast multitudes present and the impossibility of measuring even a small proportion of them are considered. It is for this reason that, while I have given measurements, and consider them necessary as furnishing a general idea of the dimensions which the corpuscles in the baboon possess, when the question is one of *comparison* be-

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tween them and the corresponding bodies in man, and involves minute differences, I rely more for a true verdict on the judgment of the eye, educated and trained by long experience than upon such measurements. Now, in none of the cortical layers, *with one exception,* have I been able to satisfy myself that in man and in the baboon differences in the size of the cells exist. That exception is the *second layer* in the frontal and parietal regions. I am confident of the fact that, while in the baboon in these situations cells are occasionally seen quite as large as, or even larger, than in man (Fig. 5), still such bodies are rare, and it may be laid down that the number and general size of the large nerve cells, which constitute what has been called the *formation of the cornu ammonis,* predominate in man. There can be no doubt of the importance of this fact, which points, I think, to the supreme position, so to speak, of the cells in question. While by no means disposed to lay down any necessary connection between size of cell and elevation of function, I cannot but think that the view above taken receives no uncertain support from other facts. Let it be remembered that it is in the anterior portion of the cerebral hemispheres, which I am content to receive, without doubt, as the parts in which the highest functions of the organ are performed, it is here, I say, that the large cells referred to are found. Posteriorly, they are quite exceptional. Let the fact be noted that, as we proceed downwards in the scale of development, it is, I have observed, these cells which vary most distinctly from the corresponding bodies in the human organ. And it is in these cells, lastly, that degenerative changes first occur when age is beginning to do its work, and *pari passu* the intellect is failing.

3.—I now pass to consider the *number of processes* possessed by the nerve cells, and the extent of their connections, which forms, as I believe, the most important of the questions under present discussion. A careful study of the subject, and a close comparison of numerous sections, have led me to the conclusion that in man *the number of the cell processes, and, as a consequence, the extent of their connections, is greater than in the baboon.* It is impossible, I consider, to over-estimate the importance of the above conclusion, if correct, or its influence on questions hitherto in obscurity. But because of its importance and far-reaching interest, is it therefore the more necessary to examine well the grounds on which it is based, and endeavour to realize the exact state of the case. Let me in the first instance say, that my remarks apply mainly to

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the large pyramidal bodies of the second layer, for at the present moment I am not prepared to include the smaller corpuscles of the other strata. It need hardly be said that in such a question as the present the difficulty is great, and the sources of fallacy are considerable. Sections of the same region may vary considerably with regard to the number and distinctness of the cell processes, according to the success and delicacy of the preparation, and not from any inherent variation of structure. Again, as before stated, the number of the corpuscles is so great that only a very minute proportion can be studied, and the connections estimated. But with these difficulties fully in view, my conclusion in the present instance is as I have stated above. I base the conclusion—1st, on actual observation. I find that in man the branches of the large pyramidal cells are generally more numerous than in the baboon; and not only so, but they branch and rebranch in a far more complex manner than I have been able to observe in the latter (Fig. 11). I believe that in man, owing to the above fact, the intercellular matrix is more largely composed of fibrils than in the baboon, so that Beale has been led to deny the presence in the matrix of any other constituent than a dense plexus of minute fibrils,* and, indeed, in the human organ such often appears to be the case, but not in the baboon.

It may be well now to inquire what collateral evidence may be advanced in favour of or against the proposition above stated, for while I am convinced of the truth of my position, there are, as before stated, fallacies and difficulties, and further, the present is but a single case.

In the human fœtus at the eighth month I have observed that the cells of the cortex have universally the form and appearance of round nuclear bodies, without any indication of branches or connections. It is not till late in life, when the functions of the cells are called into activity, that branches and processes make their appearance. Long before the present considerations framed themselves in my mind, the fact was familiar that in some of the lower animals, such as the rabbit, the cells, while differing from those in man in many respects, appeared to be decidedly less rich in branches. Lastly, in the process of atrophy of the cells in old age, we know that loss of some of the branches is one of the earliest and most constant changes. Do not the above facts render it probable that there is a relation between the functional

* Proceed. Roy. Soc., June, 1863.

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activity of the nerve cells and the number and complexity of their anastomoses? And, if so, is it not in accordance with what would be expected, that in man the arrangement should be most complex, and that, passing downwards in the scale of development, it should become more and more simple? *A priori* reasoning, therefore, it seems to me, as well as the facts now adduced, points in the same direction; and it remains to be seen whether further observation and experience will confirm my conclusions.

III.—With regard to the structure of the white medullary substance of the brain and the vessels in the baboon, I can find in neither case any variation from that found in the human organ. Without doubt, in man the *quantity* of the white matter predominates; but further than this there is no difference which I can detect.

In bringing these observations to a close, I do so with the full consciousness of their imperfection. There are very many points of great interest which I have not even named, as being at present beyond my reach, and which, therefore, would only have complicated and obscured the others. Nevertheless, if I am right in the results I have indicated, and if my observations be confirmed by further investigations, then at last, I venture to think, that some light is breaking out on this hitherto obscure and unknown region; some knowledge acquired, not vague and uncertain, but definite and secure, and some progress made in the right direction.

EXPLANATION OF PLATES.

Fig. 1. (Chacma Baboon).—First cortical layer of the brain, showing the corpuscles, their connections, &c., × 450.

Fig. 2. (Baboon).—Second cortical layer (ascending frontal convolution), × 450.

Fig. 3. (Baboon).—Large pyramidal cells of the second layer of the frontal lobe (cornu ammonis), × 450.

Fig. 4. (Baboon) —Second layer (occipital), × 450.

Fig. 5. (Baboon).—Largest cells of second layer (frontal), × 450.

Fig. 6. (Baboon).—Third layer (occipital), showing occasional large nerve cell, × 450.

Fig. 7. (Baboon).—Third layer (occipital), showing the ordinary cell elements, &c., × 450.

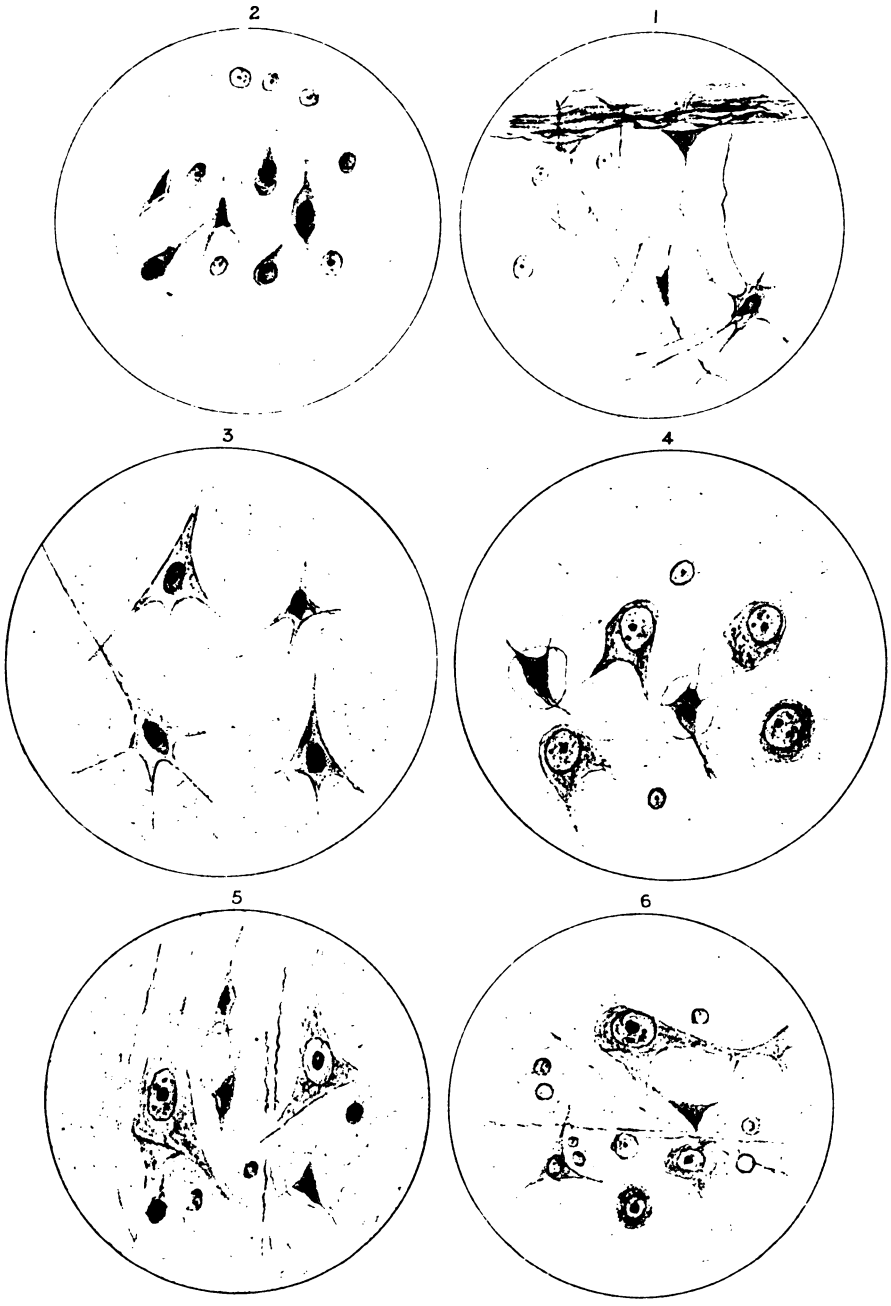
Fig. 8. (Baboon).—Fourth cortical layer, × 450.

Fig. 9. (Baboon) —Fifth layer (occipital), × 450.

Fig. 10. (Baboon).—Sixth layer (parietal), × 450.

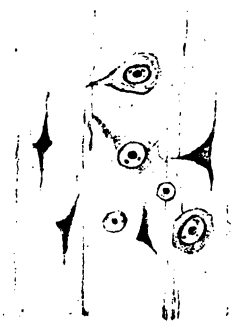
Fig. 11. (Man).—Cells of cornu ammonis, showing the numerous branches and connections, × 450.

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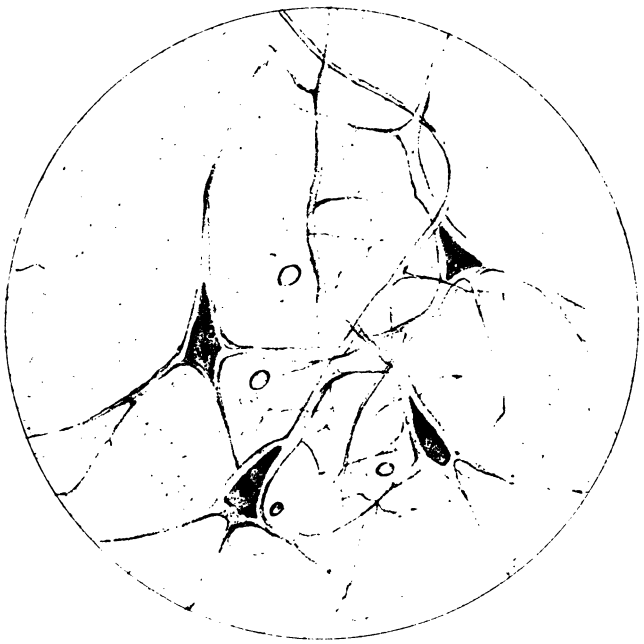
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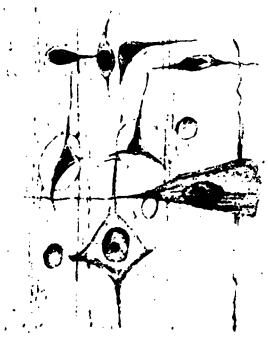
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