October 8, 1894), Prof. Barnard decided to observe it as continuously as possible, to settle this question. Tisserand's results indicated that the line of apsides of the satellite's orbit should also have a motion of + 882° a year, or + 2°·42 daily, giving a complete revolution in five months. From the Lick measures he computed the semi-major axis of the orbit to be 47″·906, the eccentricity 0·0073, and longitude of Perijove for 1892, November 1, = − 4°. Prof. Barnard's more recent measures enable him to revise these values, and his results are contained in the *Astronomical Journal*, No. 472. On calculating the position of the satellite from Tisserand's value of the motion, a considerable error is found, and the daily motion of the apse line is probably more nearly + 2°·465 or 900° yearly, giving a complete revolution of the orbit in 4·9 months.

An interesting question that may also be settled by continued observation of the satellite is the distribution of matter at the equator of Jupiter itself, as the motion of the perijove of the satellite does not agree with that deduced from the actual polar compression of the planet.

During the whole of the measures half the field of view was covered with a piece of smoked mica, through which the bright limb of the planet was observed, and the distances measured from the limb afterwards reduced to the centre by previous measures of the planet's diameter with the same instrument. The increased number of elongations measured gives a much more correct value of the period. The value now given is

11h. 57m. 22·647s.,

which Prof. Barnard considers correct to one-hundredth part of a second.

PARTIAL ECLIPSE OF THE MOON, DECEMBER 16.—There will be a partial eclipse of the moon, visible at Greenwich, during the early morning of Sunday next, in respect to which the following particulars apply:—

First contact with penumbra = 10h. 33·7m.; with shadow = 11h. 44·6m.

Second contact with penumbra = 16h. 18·1m.; with shadow = 15h. 17·2m.

Magnitude of eclipse (moon's diameter = 1) = 0·995.

First contact with shadow occurs at a point 66° from the north point towards the east, measured along the moon's limb.

Last contact with shadow at a point 59° from north point towards the west.

The eclipse is visible in Western Asia, throughout Europe and Africa, and in Eastern America.

OCCULTATION OF NEPTUNE, DECEMBER 16.—There will be another occultation of Neptune during the early morning of Sunday, while the moon is still in the penumbra of the earth's shadow after the partial eclipse. The following are the particulars for observers near London:—

	Sidereal time.	Mean time.	Angle from North Point.	Angle from Vertex.
	h. m.	h. m.	°	°
Disappearance...	9 18	15 36	158	118
Reappearance ...	9 53	16 11	222	180

Greenwich Mean Time of conjunction in R.A.... } 1899 December 16d. 14h. 53m. 15s.

Limits of latitude, 90° N. to 30° N.

Neptune passes the meridian of Greenwich at 13h. 40m., so that it will be well situated for observation of the occultation.

MERIDIAN OF UNIVERSAL TIME.—In the *Revue Scientifique*, Ser. 4, vol. 12, p. 526, M. C. Tondini di Quarenghi summarises most of the evidence in favour of and against the adoption of the meridian of Greenwich as the initial meridian for universal time. The chief objection is cited as a physical one, viz., the extreme uncertainty of the meteorological conditions, rendering celestial observations impossible on a large proportion of the days and nights throughout the year. The advantages of the site at Jerusalem suggested by the Italian Government are the superior observing conditions and the possibility of the district being declared neutral ground, thus ensuring the permanence of the station irrespective of political changes. A further advantage would be the possibility of establishing other subsidiary stations at intervals along the meridian.

THE DEVELOPMENT OF GANGLION-CELLS AND NERVES.[1]

THE results of this memoir largely are in keeping with certain revolutionary changes in embryological doctrine, with which the names of Klaatsch, Miss Julia Platt, Goronowitsch and others are identified. According to their views certain vertebrate structures, which have hitherto been genetically referred wholly or in part to the mesoderm, such as scales, certain cartilages, and even bones, are in fact directly or indirectly products of the outer layer of the embryo, the ectoderm or epiblast. This is only a brief and very general statement of the tendency of their lines of research, and it may be added that as to the details there exist important differences between the different observers. It will not be needful to review all their conclusions here. Our concern is solely with the aspect of the question presented to us by Dr. Goronowitsch in his memoir.

Researches on the development of nerves and ganglia date back to Remak, whose conclusions as to their mesoblastic origin from the protovertebræ or mesoblastic somites were commonly held as recently as twenty-five years ago. About then date the researches of Balfour and Marshall, who maintained that these structures arose as outgrowths of the central nervous system, and that therefore they were epiblastic in origin.

Later on their conclusions were somewhat modified by Beard, in the discovery that the posterior root-ganglia, both cranial and spinal, did not develop as actual outgrowths from the central organ, but that their foundations were to be traced to the deeper portions of the epiblast outside the limits of the future brain and spinal cord. It was also demonstrated that the cranial ganglia received additions from special regions of sensory epiblast, since termed by Kupffer "placodes," on the level of the notochord and above the gill-clefts. Thus, for the sensory portion of each cranial ganglion, two sources of origin could be identified, and the parts so derived were termed neural and lateral respectively. A few years ago Kupffer added a third source, and described an "epibranchial" ganglionic foundation as arising from it. Kupffer's results were obtained in the lamprey, unquestionably one of the most difficult forms among vertebrate animals for the study of organogeny. His results have never been confirmed by any other observer, either in the lamprey or in any other vertebrate.

Whilst it is certain that his epibranchial ganglia have no existence in Elasmobranch fishes, it is also in embryos of these easily demonstrated how Kupffer fell into the error of supposing their presence. In fine, had his researches been carried to sufficiently early "stages" or phases he would have seen that his lateral and epibranchial ganglia merge into one, the foundation of a lateral ganglion.

Since Kupffer's researches were fully published in 1894–5, embryological investigation of the development of cranial and spinal nerves and ganglia has been put somewhat in the shade by brilliant researches into their comparative anatomy at the hands of Allis, Dixon, Ewart, Fürbringer, Haller, Strong and F. J. Cole. Pages and pages might be filled in review of these, along with a critical digest of numerous other papers, embryological and morphological, issued since 1885. Controversies have been waged as to the morphological nature of certain nerves and ganglia, as to their mode or modes of development, and as to the way—apparently a simple problem, but by no means such—in which nerve-fibres arise.

The work under review is only in a minor degree a contribution to a knowledge of the morphological nature of nerves, *i.e.* in so far as it relates to the olfactory and auditory nerves. On the other hand, it emphatically claims to furnish decisive replies to the two latter questions, as to the mode or modes of development of ganglia and of nerve-fibres. If the conclusions drawn by Goronowitsch from his researches can be upheld, it would seem to follow that the investigations of the past twenty-five years—except those of Sedgwick—have been largely in vain.

According to Dr. Goronowitsch, what Balfour and Marshall regarded as outgrowths of the central nervous system, and termed "the neural ridges," have nothing to do with the development of the cranial ganglia. The existence of these "ridges" of cells he does not dispute, but he maintains that the component cells become resolved into the surrounding meso-

[1] Untersuchungen über die erste Anlage der Kranialnerven bei *Salmo fario*." By N. Goronowitsch. Nouveaux Mémoires de la Société impériale des Naturalistes de Moscou, T. xvi. L. 1, pp. 1-55, 3 plates.

blast. The cranial ganglia take their entire origin from Froriep's "Kiemenspaltenorganen." These structures were first discovered by Froriep, and independently by Beard, who identified them as the foundations of the lateral sense organs, and termed them, because of their genetic relations to the gill-clefts, the "branchial sense-organs." Moreover, as previously stated, these patches of sensory epithelium, the "placodes" of Kupffer, were shown to be the sources of ganglionic elements, forming the lateral ganglia. Goronowitsch has now, therefore, endeavoured to limit the cranial ganglia in their origin to these lateral sources alone.

Peculiar, though not confined to himself, are the views maintained by Dr. Goronowitsch as to the mode of attachment of the ganglion with the central organ, and as to the formation of nerve-fibre in general.

In the solutions offered of these problems—which, of course, are really one and the same, to wit, that of the development of nerve—he places himself entirely on the side of A. Sedgwick.

The latter zoologist has maintained, without thus far illustrating his thesis by figures, that nerve-fibres arise *in situ* in the mesodermic reticulum, connecting together the various portions of the developing embryo and filling all the spaces between skin and central nervous system.

The logical conclusion attaching to this view is that nerve is mesodermal in origin. This conclusion Goronowitsch does not hesitate to draw. In his own words in literal translation he says (*inter alia* on p. 40) "the nerve-forming tissue of the complex nerve-trunk is furnished by axial mesoderm."

Incidentally he, like Sedgwick, rejects the doctrines of His, Golgi and their followers, that nerve-fibres arise as processes of ganglion-cells. Naturally! The two views are mutually exclusive. If nerve-fibres arise in a reticulum of mesoderm or mesenchyme, they cannot also be processes of ganglion-cells.

Whatever is to be said for the full acceptance of the process-theory of His and Golgi, and whatever the ultimate fate of the germ-layer theory, no fact in vertebrate embryology stands on a firmer basis than the origin of all nervous structures from the outer layer, the ectoderm or skin, and to fall back upon the mesoderm or its reticulum as the source of nerve appears to us a retrograde step to the embryological standpoint of thirty years ago.

While readily and willingly acknowledging Goronowitsch's industry and zeal in working out this memoir, evidenced by the detailed and laborious description, the carefully drawn and beautifully lithographed plates, his main thesis must remain in abeyance until proof further and more convincing, that this is so for representative members of each of the great vertebrate classes, can be brought forward.

THE UTILITY OF KNOWLEDGE-MAKING AS A MEANS OF LIBERAL TRAINING.[1]

THE subject on which I wish to address a few remarks to you to-day, by way of opening the fortieth session of our College, is the utility of knowledge-making as a means of liberal training.

That the main work of the highest of educational institutions should consist of original research, and that ability to make additions to knowledge should form the chief test of qualification for the highest academic distinction, may be said to have received world-wide recognition; but the value of research work in institutions or departments of a lower grade has not been similarly recognised, and the tests for lower academic degrees and certificates do not, in general, at least formally, include a research test. I wish to bring to your notice some considerations which go to show that the work of all educational institutions, from the highest to the lowest, should be, to a considerable extent, at least, of the nature of original research—understanding by that term, however, the effort to make additions to our own knowledge, not necessarily to the knowledge of the race.

In this sense we have all been engaged more or less in original research from our earliest years; and we probably attained greater success in infancy than in youth or in later life. The young child is completely cut off from all external sources of information; and it could acquire no knowledge beyond a remembrance of confused sensations, if it did not possess the power of "putting that and that together" and finding things out for itself. By applying this power, however, the child succeeds in bringing a large measure of order out of the chaos of sensations which it experiences. The method which it uses is the scientific or knowledge-making method. It finds out the usage of a word, for example, by putting together various instances of its use, constructing a theory as to the meaning of the word, testing the theory by subsequent observation, and modifying the theory as experience widens—in fact, by subjecting its experience to imagination, induction and deduction, and thus, as the logicians would say, generalising such experience. How exactly the process is carried out, even the New Psychology has not yet told us. But it certainly gets carried out somehow; and the result is a series of brilliant, though possibly to some extent sub-conscious, discoveries. The evolutionist would tell us, perhaps, in his learned phraseology, that this phenomenon is a case of the ontogenetic recapitulation of phylogeny, by which he would mean that the young animal in learning its mother-tongue passes in a few months or years through an epitome of the course of development for which the race required as many æons. Even so, the phenomenon does not lose its suggestiveness from our present point of view.

Whether it be because, when the mother-tongue has been acquired, the period of octogenetic recapitulation is complete, and the child brought thereby up to date, or because it is then brought into communication with encyclopædic friends, I cannot say; but certainly once the child is able to question its mysterious neighbours and to understand their answers, its power of applying the scientific method rapidly diminishes, becoming weakened apparently because of the readiness with which information may now be obtained by simple appeal to authority. But though weakened the power is not wholly lost; for it exhibits itself, more or less, in the study both of language and of natural phenomena, during the period of tutelage between early childhood and incipient manhood, and it comes into greater or smaller activity when the young man goes forth to engage in the work of life. And what his degree of success is to be in such work as his hand may find to do will depend, in no small measure, upon his power of putting that and that together and making knowledge for himself from his own experience.

The value of experience in the direction of the work of life does not need to be established by argument. It has become proverbial. But the connection of its value as a directing agency with the making of knowledge may need a few words of exposition. That the mental process which enables us to learn by experience in later life is a knowledge-making process—the same as that used by the child in acquiring its mother-tongue, though perhaps more consciously performed—becomes obvious if we consider any particular kind of work in which men engage. The merchant, to take a single case, in order that he may be able to foresee what kinds and qualities of the many articles in which he deals it will be desirable for him to have in stock, must watch the purchases of his customers, and make mental note of their satisfaction or discontent. The transactions are too numerous to be carried in the memory or to admit of written memoranda. If he is to make progress in judging as to what his stock should include, he must put related experiences together, weld the lessons he learns from them into general rules, and make these rules more and more accurate as time goes on. And the same is true of many other questions which he must settle for himself. Unless, in fact, he can generalise his mercantile experience, as a child generalises its linguistic experience, he must continue to buy and sell with no greater intelligence than he did at the outset of his business career.

> "Till old experience do attain
> To something like prophetic strain,"

as Milton puts it, he can have no complete success.

A similar statement may be made with respect to the physician, the farmer, the investigator, the housewife, the artisan, the politician, the clerk,—with respect, in fact, to all classes of workers, whatever the form of work in which they may be engaged. It may be made also, not only in regard to their main work, but in so far as they may in addition be engaged in athletic, literary, artistic, political, social, religious, or any other effort, and whether that effort take the form of work or play. In short, it is applicable to a greater or smaller extent to at least the great bulk of the various forms of activity of which the lives of most of us are made up. The subject-matter of experience, the material with which we must deal, is different in different cases; but there is one condition

[1] Inaugural address delivered at the opening of the fortieth session of Dalhousie College, Halifax, Nova Scotia, on September 13, by Prof. J. G. Macgregor.