the invention, in 1887, by Abbe of Jena, of apochromatic lenses of wide aperture and homogeneous immersion, by which clearer definition is obtained together with more accurate correction of chromatic aberration The magnifying power with good definition, which was, in the earlier half of the century, limited to less than 500 diameters, is now from 1,000 to 1,500 diameters.

Besides the microscope, other optical inventions and discoveries have greatly aided the extension of anatomical knowledge. Among these should be mentioned the ophthalmoscope, invented in 1851 by Hermann von Helmholtz (1821–1894), professor at Berlin; the laryngoscope, invented in 1858 by Johann Nepomuk Czermak (1828–1873), professor at Prague and Leipsic; and the astounding discovery, made in 1895 by Wilhelm Konrad Röntgen (born 1845), professor at Würzburg, of the so-called *x*-rays, by which actinic shadows of the more solid parts of the living human body can be cast upon a photographic plate.

The question of the spontaneous generation of the cells of the body and of unicellular forms of life was naturally considered in connection with theories of development and structure. The experiments of Spallanzani and Needham on the generation of infusoria were found to be not always conclusive when repeated by others, and it was generally held that cells might generate *de novo* in the bodily fluids. This had great bearing upon questions in pathological anatomy.

A new light was thrown on this by the discovery, in 1836, by Cagniard de la Tour and by Schwann, of the *yeast plant*, which by its rapid multiplication spreads from a small quantity of leaven throughout a large mass. F. E. Schultze had previously shown that exclusion of air prevented fermentation. This led to the theory of chemical ferments (Liebig), which was in 1857 overthrown by Louis Pasteur (1822–1895), who showed that fermentation and putrefaction are due to the presence of minute living spores. The parasitic character of many disorders was shown, and it was also proved that the supposed formation of pus cells in the tissues of the body was due to the multiplication of living corpuscles already existing there or the transmigration of others from the blood-vessels (diapedesis, Cohnheim, 1867). The experiments of Pasteur, Tyndall, and others served to show that ordinary air is crowded with living particles that reproduce their kind when placed in suitable conditions. Hence arose the so-called "germ theory" of the origin of many diseases, which has had an important influence upon the development of pathological anatomy.

As an offset to the all-pervading germs came, in 1884, the discovery by Metschnikoff, professor in Odessa, that white blood corpuscles and cells of lymphoid organs have the property of destroying foreign organisms that may be introduced into the body (phagocytosis).

The most significant event in the history of anatomy, as in that of other biological sciences during the nineteenth century, was doubtless the publication, in 1859, of the "Origin of Species" by Charles Darwin (1809–1882). As early as 1837 Darwin began to collect data with reference to the variation of structure in animals and plants, and with a reticence as unusual as rare withheld his speculations until they were ripened by mature thought and corroborated by numerous experiments. The great advance that he made upon the theory of Lamarck was in recognizing the "struggle for existence" as the potent factor in producing change by inducing the "survival of the fittest" forms to reproduce their kind. Similar views were produced at about the same time by Alfred Russell Wallace, the distinguished naturalist. Darwin applied his principles to the structure of man in his work "The Descent of Man," published in 1871.

The careful and cautious character of Darwin's work, fortified as it was by the most exhaustive and minute investigations, caused it to be received far differently from that of his predecessors. The human organism evolved throughout countless ages was now seen to be a cosmic phenomenon of vast importance and significance, not an isolated and special matter dependent on the action of some unknown and incomprehensible power. The influence exerted upon all departments of anatomy was very great. No longer could the structure of man be considered by itself, it must be illustrated and interpreted by that of all other creatures. The blurred and forgotten pages of the book of life on the globe must be deciphered to give man a clew to the meaning of his own bodily form. Comparative anatomy and palæontology thus became powerful coadjutors to human anatomy, and the study of development, under Meckel's law of recapitulation, became more essential than ever.

The study of the varieties of man assumed a new importance. The groundwork of a rational anthropology had already been laid by Andreas Adolf Retzius (1796–1860), professor at Stockholm, who invented the cephalic index and introduced the principle of indexes for the classification of measurements. Other workers in this field were the Americans; Samuel G. Morton, J. Aitken Meigs, Nott and Gliddon, and Jeffries Wyman; the British; Pritchard, Lawrence, Barclay, Flower, and Tylor; the Germans; Spix, Lucae, Welcker, Ranke, Ihering, and Schmidt; and in France; Dumoutier, Jacquart, Quatrefages, and especially Paul Broca (1824–1880), who founded the Paris Société d'Anthropologie (1859), and by his great intellectual activity reduced to system the somewhat irregular methods in use before his time. Similar societies were formed at most scientific centres: London—1863, Berlin—1869, Vienna—1870, Washington—1880.

A more careful search disclosed the remains of man in strata of geologic epochs far more distant than had hitherto been imagined. Thus, in the grotto of Engis, near Liège, they were found (1835) in conjunction with the bones of the mammoth and the cave bear; in the valley of the Somme, Boucher de Perthes discovered (1846) implements of human manufacture in strata of unquestionable quaternary origin; in the Neanderthal, near Düsseldorf, there was found (1857) a remarkable ape-like skull associated with bones of the cave bear; at La Naulette, in Belgium, near Dinant, a fragment of a human jaw of very low type, together with bones of the mammoth and woolly rhinoceros; and in 1886, in the grotto of Spy, bank of the Orneau River, in Belgium, were unearthed two skeletons associated with similar bones of extinct animals. Other discoveries of like nature were made in Kent, England, near Prague, in Moravia, in the Balkan peninsula, in Bohemia, at many places in France, in the pampas of South America and in Patagonia, the latter being associated with the huge carapaces of the glyptodon. The most remarkable find of all was, however, that of Dr. Eugène Dubois, who during explorations in Java (1890–1895) discovered a fossil skull cap, a femur, and two molar teeth embedded in rock and associated with the remains of extinct animals belonging to the Pliocene epoch. These remains appear to be transition forms between those of the higher apes and the lowest existing men.

At the time of Darwin the intimate structure of the cell was little understood or considered, but the researches of Oscar Hertwig, van Beneden, Flemming, and many others have shown the great importance of this branch of anatomical inquiry, and it is about the problems here found that the principal discussions of more recent times have been raised.

In 1866 the lowest form of a cell was considered to be simply a mass of structureless protoplasm endowed with vital properties, the cell membrane and the nucleus having been successively dismissed as non-essential elements. Protoplasm was considered as a homogeneous, semi-fluid substance, with little or no trace of organization, whose chemical constitution was only approximately known, but was believed to be highly complex. Some daring spirits ventured to surmise that it might be possible to produce protoplasm in the chemical laboratory.

The elaborate investigations of recent years have shown the futility of such a pretension, indicating that protoplasm has an almost inconceivable instability, that it differs in composition in different cells, in different parts of the body, and under different stimuli. The substances of which it is composed are among the most complicated

known to chemistry, and there is reason to suppose that in the living body it is much more unstable than in the cadaver. There appears to be a wide distinction to be made between those *organic* bodies that are products of secretion and excretion such as sugar, starch, and urea, and the *organized* bodies such as the different protoplasms that are produced by the slow and peculiar processes of biotic growth.

The morphological character of protoplasm has also been found to be much more complicated than had been supposed. First granules were observed, then striations, then vacuolizations. The appearances being often contradictory and varying much with varying conditions, it is not surprising that they have led to diverse views as to its structure. These are by no means settled as yet, but they may be succinctly grouped as follows:

1. The *reticular* theory, first brought clearly forward by Karl Heitzmann (1830–1896) in 1873, and still maintained, under various modifications, by a great number of cytologists. According to this all protoplasm is composed of two substances: a more solid network—the cytoreticulum or spongioplasm, and a more fluid interstitial substance—the cytolymph, hyaloplasma, or enchylema. The granules observed in cells, when not foreign inclusions or masses of dead protoplasm, are the intersections of this network. There is no doubt but that the great majority of cells, when fixed by the usual methods and treated with staining reagents, show some traces of such a reticulum.

2. The *filar* theory, advocated by Flemming (1887), who by studying cells unaffected by reagents concludes that they are structurally composed of free threads, the cytomitom, not combined into a reticulum but often containing numerous nodosities.

3. The *granular* theory, first brought forward by Arndt, and afterward advocated by Altmann (1887). This supposes protoplasm to be formed of granulations embedded in a homogeneous basis substance. These granules, Altmann's bioblasts, are held to be themselves morphological units of a still lower order than the cells. Special means of preparation are required to demonstrate them.

4. The *alveolar* theory, of Bütschli (professor at Heidelberg, 1889) and his school, who hold that the structure of protoplasm is like that of a fine viscous froth or foam, that is to say, composed of alveoli with extremely thin walls. This structure is believed to be a physical consequence of the peculiar conditions of tension and surface flow possessed by the substance, and may be imitated by emulsions of thickened oil and various salts. This view attempts to explain the appearances of the other theories either by the optical conditions under which the alveoli are viewed or by the reaction of the reagents employed. To demonstrate the alveoli in perfection the protoplasm must be living and the best attainable optical conditions secured. Under such circumstances they are seen actively to change their forms and relations to each other, these phenomena being so swiftly evanescent that it is impossible accurately to represent them in a camera drawing,—while the hand is tracing one part another is rapidly changing.

Attempts have been made to reconcile these conflicting views. Kölliker considers that the different appearances are due to different states of development of the protoplasm. In young cells he supposes it to be homogeneous and without structure, formed of a mixture of various substances possessing different degrees of contractility and solubility in acids. In such a medium vacuoles will sooner or later appear. If these are numerous and small the structure of the protoplasm will be alveolar; if the walls of the alveoli break it becomes reticular; if the threads of the reticulum break it becomes filar. Doubtless this view may assist us in certain interpretations, yet it must be said that recent observations tend to show that even the earliest ovum does not possess a homogeneous structure.

Among the differentiations of the protoplasmic mass of the cell the nucleus has been the most successfully investigated. Flemming was the first to show that it contains several substances, one of which, from its affinity for coloring matters, he named chromatin. The phenomena of indirect cell division (mitosis, karyokinesis) were first connectedly observed by Anton Schneider in 1873, although Balbiani and others had previously noted separate stages. The nuclear reticulum which plays so important a part in this process was first noticed by Frommann in 1865. The fragmentation of this into separate sections or chromosomes was shown by Balbiani and Carnoy. These again are separable into granular bodies, to which the name of chromomeres has been given by Fol (1891). Other investigators who have greatly advanced the knowledge of this process are Strasburger, Boveri, Oscar and Richard Hertwig, van Beneden, and Rabl.

The great advance made in theoretical chemistry by the atomic theory of Dalton (1808) is well known. Although atoms and molecules have never been seen, the hypothetical constitution of bodies supposed to be formed by them is now definitely stated and predicted. The signal success of this theory has led to similar speculations regarding the constitution of protoplasm. The first of these was that of Nägeli, who in 1884 propounded his *micellar hypothesis*. According to this, protoplasm is composed of an immense number of "micellæ," elementary units of a crystalline character, far beyond the limits of microscopic vision. As molecules are formed of atoms, so micellæ, units of a next higher order, are formed of molecules. The peculiar physical properties of protoplasm, its imbibition of water, etc., are explained by the arrangement and affinities of the micellæ.

The hypothesis of Nägeli has led the way to a number of others of a similar character by De Vries, Wiesner, Haeckel, Hertwig, Roux, and Weismann. These have generally been directed toward explaining by this means the phenomena of heredity. By a series of beautiful experiments (1884) Oscar Hertwig has apparently succeeded in showing that the physical substance upon which this transmission of characters depends is the chromatin found in the cell nucleus.

Starting with this for a basis Weismann, in various publications from 1875 to 1894, has propounded an elaborate theory by which he attempts to explain the phenomena of hereditary resemblance. According to this, the chromatin is a structure of almost inconceivable architectural complexity. In his system Weismann, following Nägeli, names it "idioplasm," and supposes it to be composed of groups called "ids," corresponding to the chromomeres seen under the microscope. During the segmentation of the ovum or any other cell division, these ids also divide, so that they are distributed to each cell throughout the body. The ids are themselves composed of lesser units called "determinants," because they determine the histological character of the cells within which they dwell. There are as many kinds of determinants as there are parts of the body capable of being different. Determinants are themselves compound, being composed of "biophores," or ultimate units that control the vital activities of the cell.

In the segmentation of the ovum certain of the cells divide so that each division retains exactly similar determinants and thus remains equal in capacity to the original ovum. Such *duplicative* division produces the tissue denominated "germ plasm" found in the nuclei of the germinal cells of the ovary and testis. Other of the cells divide by a *differential* division by which determinants of different kinds are sorted out, grouped together, and relegated to different cells. These are the somatic or body cells from which the general tissues of the body are formed. Since the germ cells and body cells separate at the earliest stage, no modification of the latter can affect the germ plasm, hence it is denied that characters acquired by the body cells can be transmitted to the offspring.

The arrangement of the determinants by which bodily characters are affected is caused by architectural peculiarities inherent in the original ovum and spermatozoon. There is contained within each fecundated ovum an entirely closed system of interrelated units that can only develop in a predetermined manner. We have here a reappearance, under a new form, of the theory of preformation sustained by Haller and combated by Wolff.

Closely connected with this is His's theory of germinal foci (1874), which supposes that within the protoplasm of the egg the different parts of the adult body are prelocalized and distinct, although not yet formed. To this view many eminent anatomists and embryologists have adhered, but recent experiments of Hertwig, which show that when the segments of a dividing ovum are shaken apart each may develop into a complete individual, appear to have dissipated these ingeniously devised theories as a puff of wind lays prostrate a house of cards.

Among the most ardent and indefatigable investigators in the domain of general anatomy during the nineteenth century should be mentioned Jacob Henle (1809–1885), professor at Zurich, Heidelberg, and finally at Göttingen. He was among the first to realize the importance of the cell theory and did much toward its establishment. He also advanced what may be called the modern theory of pathological processes, holding that they are merely modifications of those of health.

Albert von Kölliker (born 1817), professor at Zurich and Würzburg, still living full of years and honors, has also had great influence upon research both in general anatomy and embryology.

In comparative anatomy should be mentioned Richard Owen (1804–1892), the author of a curious theory of the vertebral origin of the skeleton, and Thomas H. Huxley (1825–1895), who by his writings and researches greatly furthered the doctrine of development by descent, and Carl Gegenbaur (born 1826), at Heidelberg, whose researches upon the morphology of the head and limbs are justly famous. In the palæontological field great advances have been made by the discovery in America of fossil deposits of great extent, and of importance far surpassing anything hitherto known. These have been especially investigated by Joseph Leidy (1823–1891), professor in the University of Pennsylvania; by O. C. Marsh (1831–1899), professor in Yale University; Edward D. Cope (1840–1897), professor in the University of Pennsylvania; Henry F. Osborn (born 1857), professor in Columbia University; and G. Baur, professor in the University of Chicago. They have thrown great light upon human anatomy by confirming in a striking degree the theories of development and the morphological laws controlling the formation of the human body. The anatomy of the head, of the teeth, and of the vertebral column have been especially elucidated.

The advancement of embryology has been greatly aided by the anatomists whose names have been already given, and also by Johannes Müller (1801–1858), professor at Bonn and Berlin, one of the most learned men of his day, who especially studied the development of the genital organs, the glands, and the peritoneum, and by Francis M. Balfour (1851–1882), professor at Cambridge, whose tragic death on the Aiguille Blanche of the Alps was a great loss to science. An important advance in the establishment of the phyletic history of man and other animals was made in 1874 by Ernst Haeckel (born 1834), professor at Jena, who attempted to show that all animals possessing a food sac or intestinal cavity are descended from a common ancestor (as yet hypothetical), the *Gastræa*, and that this is represented in embryological development by a stage which may be termed the gastrula, formed by the invagination of the blastodermic vesicle or blastula. This, the celebrated *gastræa theory*, aroused violent opposition from the opponents of the development hypothesis, but is now quite generally accepted.

The details of the intracellular phenomena of the fecundation of the ovum were first observed by Oscar Hertwig in 1875, in the transparent eggs of the sea urchin.

In osteology during the century there should be noted the work of John Goodsir (1814–1867) on the structure and development of bone, the discovery of the lacunæ and canaliculi by Purkinje, and that of the osteoblasts by Gegenbaur (1864). William Sharpey (1802–1880) did much to increase the knowledge of the structure and development of bone, as also did Ollier and Robin in France and H. Müller, Gegenbaur, and Kölliker in Germany. The architecture of the spongy tissue of bones has received especial attention from Jeffries Wyman of Harvard University and from H. von Meyer of Zurich. The development of limbs in vertebrates has been studied by R. Wiedersheim of Freiburg, the form of the skull by R. Virchow of Berlin, and Welcker of Halle, the general morphology of the skull by Götte of Strasburg, and Gegenbaur (1887). The vertebral column has been investigated by Cunningham of Dublin, Merkel and Henke.

Arthrology has made important advances in precision and knowledge of the mechanism of joints. Especially worthy of mention are the works of Meyer of Zurich, Braune of Leipsic, Morris of London, Heiberg of Christiania, and Bigelow and Dwight of Boston. Bland Sutton, of London, has investigated the nature of ligaments, Bernays, of St. Louis, the development of joints.

In myology the minute anatomy of muscle has received particular attention, but cannot yet be said to be settled, as a knowledge of the intimate structure of protoplasm is as yet imperfect. Bowman, in 1840, was the first to throw any clear light on the subject. He was followed by Leydig and Cohnheim. Afterward Krause (1868) brought forward his theory of "muscle caskets," Hensen showed new details, and Merkel, Engelmann, Rollett, and Ranvier respectively advanced their views. The general morphology of the muscular system has been advanced by the researches of Huxley, Humphry of Cambridge, and Gegenbaur; the study of muscular anomalies has been pursued by Wenzel Gruber, Theile, Wood, Macalister, Struthers, Chudzinsky, Testut, and Ledouble. Special groups of muscles have also received attention, Fürbringer studying those of the larynx and of the shoulder, von Bardeleben and Cunningham those of the hand and foot, Ruge those of the face.

In the earlier part of the century the structure of the capillaries was not understood, it being believed that they were interstitial lacunæ without walls. The demonstration of their independence and continuity was first made by Treviranus in 1836. The endothelium of the blood-vessels was first demonstrated by Henle in 1838. Johannes Müller made important discoveries in the vascular system, especially that of the helicine arteries of erectile tissue, in 1835.

The study of the formed elements of the blood has greatly advanced, but still leaves much to be desired. The blood platelets (hæmatoblasts or third corpuscles) were first discovered by Max Schultze in 1865, and were afterward studied by Bizzozero, Hayem, and Pouchet. Ehrlich (1891) carefully studied the white corpuscles and separated them into varieties that appear to be of great value in pathological anatomy. Neumann and Malassez have investigated the origin and formation of the red blood corpuscles.

Other angiological studies of note are those of His and Bernays on the development of the heart, of Braune on the venous system, and of Bardeleben, Thoma and Bonnet on the variations in the structure of the vascular walls. Heubner (1872) greatly elucidated the vascular distribution in the brain. A profound study of vascular anomalies has been made by W. Krause.

The lymphatics, formerly believed to originate from the interstitial spaces of connective tissue (Ludwig, Brücke), were shown by Recklinghausen, Kölliker, and Ranvier to form a closed system. The true nature of the lymphatic glands has been elucidated by the labors of His, Klein, Ranvier, and others. Important investigations into the origin of the lymphatics have been made by P. C. Sappey (1810–1896), professor at Paris, and by Ranvier. The connection of the serous cavities of the body with the lymphatic system has been studied by Schweigger-Seidel, Klein, Tourneux, and Kolossow. The lymphatic tissue of the throat (pharyngeal tonsil, etc.) has been the object of research by Killian, Stöhr, Flesch, and others; and von Davidoff and Klatsch have shown

that the lymphoid tissue of the intestine, the mesenteric glands, and the spleen are all developed from the intestinal epithelium, a conception which Stieda has extended to the thymus gland. Finally Heidenhain has demonstrated the wandering of leucocytes throughout glandular tissues.

The convolutions of the brain were thought by the earlier anatomists to be arranged without definite order, being compared to the irregularities of the coils of the small intestine. In 1855 Gratiolet (1815–1865), by a careful comparative study of the brains of man and animals, showed that the apparently confused complexity can be reduced to a comparatively simple plan. This was further developed by Pozzi, Leuret, Ecker, Giacomini, and others.

Closely connected with this is the discovery, first made by Broca, that certain motor and sensory activities can be located in definite areas of the cerebral cortex. He noted that the loss of articulate speech known as aphasia is usually associated with a lesion of the left third frontal convolution (Broca's convolution). This doctrine has been greatly expanded by the experiments of Fritsch and Hitzig, Ferrier, Charcot, Horseley, and many others, and has become of great diagnostic value. It will be perceived that it only superficially resembles the older doctrine of Gall and Spurzheim.

The nerve cells in the brain and spinal cord were probably first mentioned in 1833, by Christian Gottfried Ehrenberg (1795–1876), professor at Berlin. They were better described, however, in 1836, both by Gabriel Gustav Valentin (1810–1833), professor at Berne, and Johannes Evangelista Purkinje (1787–1869), professor at Breslau and Prague, from whom are named the cells or corpuscles of Purkinje in the cerebellum. They were for some time misunderstood, Magendie, in 1839, describing them as infusoria. Their nervous character was established in 1844 by Robert Remak (1815–1865), professor at Berlin, who at the same time suggested their connection with nerve fibres.

The first to note the axis cylinder process or axone of nerve cells appears to have been Rudolph Wagner (1805–1864), professor at Göttingen, but its true nature was first shown by Otto F. K. Deiters (1834–1863), professor at Bonn, in 1865. Although unable to demonstrate its actual continuity with the axis cylinder of a nerve fibre, he gave to the process the name by which it is generally known and also named the protoplasmic processes or dendrites. The connection of nerve cells with nerve fibres remained for some time obscure. Counting experiments instituted by Benedict Stilling (1810–1879), of Kassel, showed that at the level of the second cervical nerve there are found not more than half the number of fibres that reach the cord by the posterior nerve roots.

Since the direct methods of anatomical research failed to resolve the complex architecture of the nervous system, recourse was had to the indirect methods of physiological experimentation, pathological lesions, and embryological development. In 1833 Marshall Hall, of London (1790–1857), first clearly demonstrated reflex movements and the independent action of the spinal cord and the medulla oblongata, already surmised by Descartes. As early as 1839 Nasse showed that when a nerve is cut its peripheral end degenerates, and in 1850 this was more carefully studied by Augustus Waller (died 1870), who showed that it is always the end that is detached from the nerve cell that perishes, and that when the posterior root of a spinal nerve is severed between its ganglion and the cord, an area of ascending degeneration will ascend to the cord. In 1852 Ludwig Türck, of Vienna (1810–1868), showed that a descending degeneration might occur from a lesion of the cord. Following these were similar experiments by Burdach, Goll, Charcot, Vulpian, Kahler and Pick, Gowers, and many others, showing the results of lesions of the brain or cord in producing degenerations.

Connected with these are the experiments instituted by Bernhard von Gudden (1824–1886), professor at Munich, which showed that when, in a young animal, a nerve root or nerve tract is torn away or injured, the group of cells with which it is centrally connected suffers atrophy. Among the experimenters in this line of work there may be mentioned Hayem, Forel, and von Monakow.

Many investigators had noticed in sections of the brain and cord a difference in coloration between fetal and adult structures which varied with advancing growth. It was Paul Flechsig, of Leipsic, who first showed that this was due to the fact that different groups of fibres develop their myeline sheath at different epochs, and that by this means certain fibre systems can be made out that correspond in general to the results obtained by degenerations. Improvements in technical methods have made this means of research comparatively easy, and such investigations of the nervous system have been carried on by Bechterew, Edinger, Darkschewitch, and others.

Observations in the comparative anatomy of the nervous system have also led to important results. In this field should be mentioned the names of Theodor Meynert (1833–1892), professor at Vienna; Mathias Duval, professor at Paris; and E. C. Spitzka, professor at New York.

By a combination of these methods there was gradually evolved a general idea of the architecture of the central nervous system. This was, however, necessarily somewhat vague and indefinite as long as the minute anatomical relations could not be actually demonstrated. Power to do this was at last obtained by the improvement in technical methods which made it possible to demonstrate the finest ramifications of the nerve cells. Hence arose the *neurone theory* as advanced by Ramón y Cajal, van Gehuchten, Lenhossék, and supported by Kölliker and Waldeyer. According to Joseph von Gerlach (died 1896), the protoplasmic processes of cells unite in a fine anastomotic network upon which all sensory impressions are discharged and from which, in some mysterious manner, all motor impulses originate. This doctrine was opposed by His (1886) on embryological grounds, by Forel (1887) on pathological grounds. The new methods of staining showed that nerve fibres are merely elongated processes of nerve cells. This led to the conception that the nervous system is composed of histological units (termed neurones by Waldeyer) which may comprise a cell body with its extensions, the protoplasmic processes, the axis-cylinder processes, the nerve fibres, and end organs. These units are held to be substantially independent of each other, never uniting to form a plexus. This view, which has been used with great success to explain the architecture of the nervous system, is now accepted by most histologists. It should be noted, however, that the recent investigations of Apáthy (1897) on the earthworm and leech seem to show that it may require some modification.

The internal structure of the body of the nerve cell has also received much attention and is still under discussion. Remak and Max Schultze considered it fibrillary with interstitial granules. Franz Nissl, by peculiar methods of staining, thinks that he has shown that the structure is not fibrillary, but that two substances exist, one being masses of stainable granular substance (Nissl bodies, tigroid substance), the other unstainable. He considers that different types of cells exist distinguishable by the arrangement of these substances.

The finer anatomy of the organs of special sense is almost wholly the work of the nineteenth century. The development of the eye has been most carefully investigated by Hatschek, Ayers (of Cincinnati), and Kupffer, and the curious discovery was made by Ahlborn (1886), Rabl-Ruckhard, and Spencer that the pineal body is a vestige of an eye that occurs in some reptiles. The anterior limiting layer of the cornea was discovered by Sir William Bowman (1816–1892), professor at London; the scleral sinus (canal of Schlemm) was first described by Schlemm (1830), but was previously known to Albinus, as appears from a catalogue of his preparations. The ciliary muscle was first demonstrated as such (in the sheep) by William Clay Wallace, of New York (1835). Brücke (1846) and Bowman (1847) afterward described it. Even the deep circular fibres whose discovery is usually ascribed to H. Müller appear to have been seen